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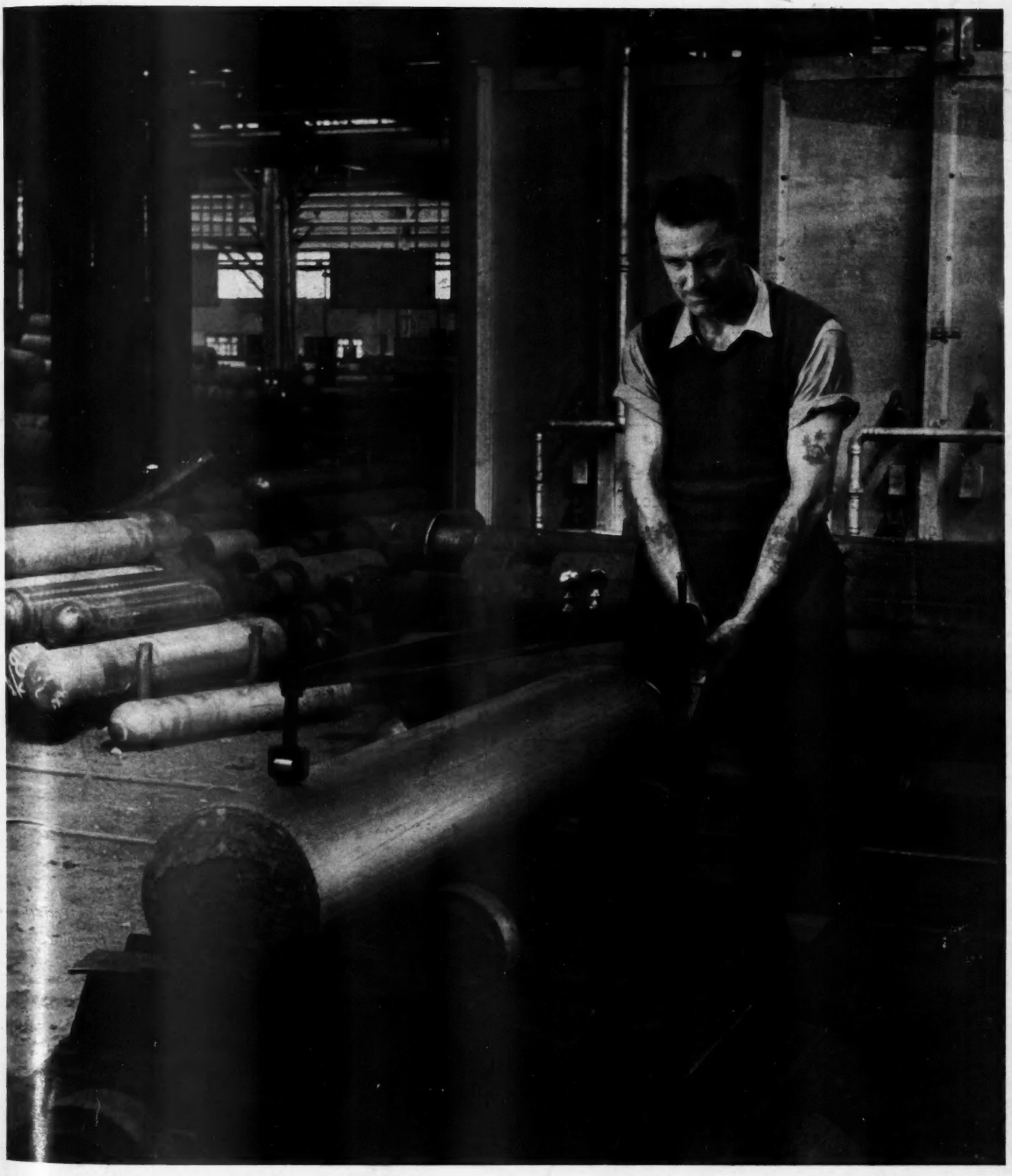

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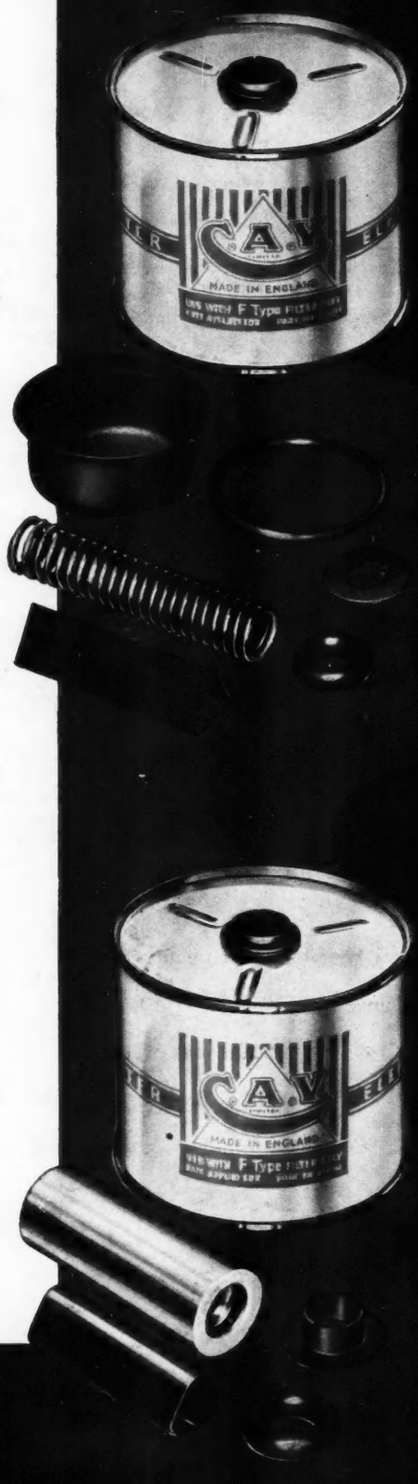

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A SQUARE DEAL

A VERY large employer of labour, it might be thought, is necessarily very powerful in the conduct of its affairs. Yet the British Transport Commission—perhaps the largest employer in Great Britain—is weaker than the smallest of businesses. Its freedom to adjust freight and passenger charges is so hedged about by statutory requirements that it is repeatedly prevented from matching its charges to conform with rising wages and costs. In four of the seven years working since nationalisation the result has been a deficit. A consequent reluctance to grant more than the bare minimum of wage demands has thus fostered labour unrest, and the members of the Commission have been disproportionately occupied with handling the difficulties created. Wages and charges have loomed too large at a time when, with prosperity almost universal, they could have been of minor importance. Everyone has suffered—the public, the Commission and the railwaymen. And it has all been for the sake of less than one per cent. of the total gross receipts during those seven years; for that is what the cumulative net deficit of £39 million is equivalent to. The Commission's plight has provided a favourable opportunity for road transport interests to strengthen their position, and a senior Army officer has even discussed converting the permanent way to roads.

This is a deplorable situation. Public confidence in the Commission and in British Railways has weakened, traffic has fallen, the Commission has been forced to redouble its efforts to cut costs (as in the closing of unremunerative lines) and a good deal of the vigour which should have sprung from the £1,200 million modernisation plan has been lost. Increases in railway charges are not welcome, but they should be accepted during a period of rising costs. Yet from 1948 to 1954, the average amount received by British Railways has actually decreased from 1·38*d.* per passenger mile to 1·35*d.* If ever the railways were justified in pleading for a square deal they are now. In its annual reports to Parliament, through the Minister of Transport, the Commission has shown commendable patience, but it is time that Parliament, in the best interests of the nation, took the initiative and demanded a workable financial arrangement. There is no valid reason why the nation should not thus "will the means."

The £1,200 million modernisation plan has shown that the Commission is not deterred from optimistic forward planning by the frustration of these circumstances which are outside their control. Nor was there any lack of technical progress in 1954, as the annual report published last week has shown. During the year, the replacing of railway coaching vehicles and wagons proceeded at a faster pace than in any previous year (excepting 1950 for coaching vehicles); this was due to better availability of materials, to changes in the working of controls over capital investment, and to improved productivity from the longer manufacturing runs ensuing from standard designs. Some progress was therefore made towards clearing accumulated arrears of replacement. But there are still substantial arrears of rolling-stock building. The permanent way, stations, goods depots, motive power depots, signalling, and marshalling yards were improved in certain areas. Electrification of the Manchester-Sheffield-Wath line was completed. Work was done on changing the electric power frequency of the Southern Region from 25 to 50 cycles. The number of Diesel shunting locomotives was increased to 309, and a large programme of multiple-unit Diesel car construction was begun. About 4 per cent. of the coaching stock was replaced in 1954, compared with 2 per cent. in 1953, and a greater number of new wagons was taken into service than in any year since 1924. London Transport, too, opened a "new phase in capital development," in the enlarging and modernising of facilities for the overhaul of buses, in the replacement of the trolleybus fleet by Diesel-engined buses, in the development of an entirely new design of bus (the "Routemaster"), in the construction of prototype tube trains with steel framework, light-alloy panelling and rubber instead of steel suspension, and in seeking powers to construct a new tube (Route "C").

The report records also the details of many specialised researches and inquiries that were undertaken. There can be no doubt that a progressive spirit has infected the Commission and its staff, as in industry generally. It is altogether unreasonable, therefore, that this spirit should be clouded by the Government's failure to free the State transport system from unnecessary shackles. Revision of the freight charges system has been under review, or in a pigeon hole, since 1951. It must be completed with the least possible delay. Wage difficulties will then be more readily overcome, the morale of railwaymen will be raised, public confidence will be restored, and a major service will take its proper place in the nation's livelihood. Then, and then only, can the Commission and its senior officers attend to their proper function. They are a policy-forming body, not a defensive organisation for emergency situations. And there are questions of policy, barely hinted at in the annual report, which should certainly engage their attention when they are free.

Weekly Survey

Cover Picture. *Stages in the manufacture of steel tubes and cylinders for the transport and storage of compressed industrial gases have been seen in two previous cover pictures. The first stage was the piercing of solid steel billets in a vertical press, and the second, the descaling of the pierced billets prior to further working. This week's cover picture shows the type of gauge used for measuring the wall thickness of an oxygen-cylinder "hollow" to ensure that it is uniform throughout its length.*

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RESERVED ROADWAY SYSTEM ON RAIL

In 1954, the British Transport Commission's consolidated revenue account showed a deficit of £11·9 million compared with a surplus of £4·2 million in 1953. Thus three years of deficits, having been followed by three years of surpluses, have been succeeded by a seventh year showing a deficit. A feature of the year's activities was the fall in net traffic receipts by British Railways. The financial position of the railways was in fact made difficult by the uncertain outcome of continuous wage negotiations and rising materials prices. The Commission continues to be faced with the difficulty of making its revenue keep up with continually increasing costs. There is no sign yet—quite the reverse—that the railways are winning back lost ground from the roads.

Point is thus given to the recent paper given by Brigadier Lloyd, the deputy engineer-in-chief at the War Office, to the Institution of Civil Engineers on the potentialities of the British Railways system as a reserved roadway system. Brigadier Lloyd's paper examines the case for converting 20,000 miles of permanent way into roadways reserved for fast through-running pneumatic-tyred vehicles. The case is set out in terms of riding quality, gradient, alignment, width, intersections, capacity, method of operation, economics, manpower, speed and strategical issues. He points out that the high riding quality of the railways is due to the permanent way, which runs straight and true. He thinks that a road surface on the permanent way could reproduce the riding qualities of the railways. Some interesting figures are also produced about petrol consumption on gradients, which suggest possible significant economies with a horizontal roadway system. The capacity of the system is put at 1,000 vehicles per hour corresponding to a vehicle spacing of 100 yards at 60 m.p.h., which it is suggested would become the minimum acceptable journey speed. After conversion, 60-seater bus-trailer convoys, dispatched at a rate of one every 1½ minutes from each of Waterloo's 21 platforms, would carry away 50,000 seated passengers per hour. This rush-hour flow of vehicles (840 per hour) would not take up the full capacity of one single lane.

So far as operation is concerned, British Railways offer a service of 20,000 million passenger miles and 22,000 million ton miles a year. The author equates this to 2,500 hours a year for 10,300 vehicles travelling at 60 m.p.h. for eight hours a day, six days a week—one-third being 40-seater buses and two-thirds 20-ton lorries. He thinks that the reserved roadway could achieve such a figure with comparative ease. Freighting potentialities would include the use of trailers towed in string at high speed. The paper makes the interesting coincidental point that a fleet of 10,300 vehicles would remove the need for railway signal-boxes, which happen to number 10,300. The paper, interesting as it certainly is, would have benefited from a rather fuller treatment of the strategical problem and the effect of substituting road for rail transport on the import fuel bill.

The technical arguments are challenging; the economic case too has its attractions. Brigadier Lloyd points out that motor-ways costing £200,000 per mile at a total bill of somewhere between £120 and £160 million have been shown to be economical. As he reasonably points out, if such figures are acceptable for motor-ways in the open country, the return on a roadway system having access to the centre of London, to mention only the biggest conurbation problem, must be very much higher. The most difficult problem of all in accepting schemes of this kind as practical propositions is that of timing. The ideal moment for a massive switch from rail to road would be at a time of inflation when road building costs are high and the railways are hampered by shortages and old equipment and can be made to surrender their very large capital assets at historical cost. Such a situation existed in this country, say, five years ago. To-day the railways are to be modernised at a cost of £1,200 million. It would take a massive reversal of policy, administration and public opinion to scrap a sufficient length of permanent way to give a scheme like this a reasonable chance to prove itself.

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TEACHING NATIVE PEOPLES

The problem of introducing primitive peoples to the disciplines and complications of industrial life is vividly described in an article by Mr. F. Rodseth, M.B.E., Native Affairs Adviser to the Anglo-American Corporation of South Africa, in the Corporation's quarterly review *Optima*. He describes the contrast between the upbringing and the social and economic behaviour of an African born into a tribe and the habits of the society to which he is expected to conform when he obtains industrial employment. The economics of the tribe does not depend on the use of money, but on accepted social customs; nor is it dependent on the use of expensive tools or on rigid time-keeping. The native concludes, therefore, that these new ideas are mere idiosyncrasies of the white man, to be abided by—so as not to hurt his feelings—when the European is present, but to be forgotten or ignored when he is out of sight.

Mr. Rodseth believes that, though his disadvantages are great, the native is willing to learn. The first need is to teach him what to do, but—even more—why it is done and how the whole project in which he is engaged works. First, however, there must be some basic education. His lack of background and previous knowledge can never be over-emphasised, though his innate intelligence is often greatly underrated. The second need is to do these things quietly and slowly in a language he can follow. Harsh and rapid speech cause bewilderment and create resentment that may last a long time.

Thirdly, appreciation of the native's difficulties should extend beyond hours of work. Particularly should this be so if he is injured. In his own environment this sympathy is a feature, for he does not regard injury or early death as due to natural causes, but as a result of machinations by some enemy or ill-disposed person. He may think that those who have been harsh to him are the authors of his misfortune. Above all, assaults and swearing should be suppressed at all costs, for these bring about hatred and bitterness on the part of the native and loss of prestige for the European.

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PRICES TOO LOW?

Allegations of "dumping" by British electrical plant manufacturers were made last week in Australia by the Associated Chambers of Manufacturers, who complained that the prices quoted by certain British manufacturers were so much below the highest United Kingdom price—50 per cent.—that they could hardly have been economic. The highest Australian price was 78 per cent. above the lowest British price, and the A.C.M. took the view that there was evidence of some considerable price manoeuvring by some companies to establish themselves in the Australian market. These allegations coincided with the publication of a report by the Australian Tariff Board on the cable industry in which it dealt with charges of dumping made against British cable manufacturers. The Board found the evidence inconclusive, but recommended the imposition of a British preferential duty of 10 per cent. on items designed for use at working pressures not exceeding 11,000 volts. The duty asked for by four major Australian firms who applied for protection was 17½ per cent., and the recommendation for a 10 per cent. selective tariff, leaving high-voltage cables and thermocouple, compensating or extension leads on the duty-free list, therefore falls short of the local industry's requirements.

The trade problems of Australia are becoming steadily more acute as secondary industry struggles to increase its markets and finds the need for protection ever more urgent as competition for world trade between the major exporting countries—and indeed between companies within those countries—becomes more intense. The Associated Chambers of Manufacturers of Canberra can, as they did, argue that the difference between the highest switchgear tenders in both countries was not high but the fact remains that British electrical manufacturers have been quoting highly competitive prices throughout the world, particularly in the United States. The A.C.M.'s allegations—supported they say by Australian investigations in London—will doubtless be the subject of an official inquiry by the Australian Tariff Board.

Clearly, these are symptoms of greater difficulties to come in trading with a country bent on industrialisation: British manufacturers must understand Australia's own problems and do all they can to help the country along the paths of its own choice, for in its prosperity lies our own intimate interests. To this end it may be necessary for the Chambers of Commerce, the Federation of British Industries or some other representative body to set up a permanent committee to study Australian needs and to effect liaison between the Australian Government and British industry. A frank interchange of views at an early stage could avoid a great deal of friction and bad temper.

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COLLECTIVE DISCRIMINATION

At the end of 1952 the Board of Trade instructed the Monopolies Commission to undertake an investigation into the effect of collective discrimination on the public interest. Their report was issued as a White Paper last week (Cmd. 9504, 3*s*. 6*d*.). It should be emphasised that the inquiry was into collective practices by trade to control or restrain the flow of goods, not into monopolistic practices as such; that is to say, the activities of an individual supplier in a monopolistic position was outside the terms of reference of the Commission. The investigation therefore covered the activities of traders in carrying out certain collective agreements to favour groups of customers, including selling or buying or limitation of entry into a trade and the prohibition of developing new ideas. Broadly, the committee of the Commission which carried out the investigation decided that such practices are not in the public interest and that legislation should be devised to eliminate them.

The outstanding impression from the report is the lack of unanimity in the findings. Seven members of the committee are in favour of legislation to control collective discrimination one member does not think that collectiv arrangements for the enforcement of resale prices are against the public interest, and three members do not consider that such practices are generally injurious necessitating their prohibition by law. They think that a general registration procedure for such arrangements should be sufficient to prevent their becoming a serious abuse. This is a solution which the majority of the committee considered but turned down in favour of legislation. It is likely that there would have been even more disagreement if the terms of reference had not been confined to collective arrangements. Nothing is more difficult to draft than legislation

to control monopolies or some aspect of restraint of trade, without creating a maze of legislation rendered all the more confusing by anomalies which may be discovered only in the light of interpretation of the law by the courts.

To some extent resale price maintenance, collective discrimination and monopolistic practices used by individual traders all hang together. Those who dislike any one of these are likely to dislike the others, while those who would adopt a tolerant attitude to any one will be inclined to be tolerant to the others. In the end it is likely to be public opinion—one hopes informed public opinion—which decides whether legislation shall be used to control monopoly or any other kind of restrictive practice. If the trend is towards some sort of statutory control it is desirable that a beginning should be made where the issues can be most clearly seen and drafted into legal phraseology.

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STRIKES LOSE EXPORTS

Forthright warnings of the damage done to Britain's export trade by the recent series of strikes were contained in ministerial speeches delivered during the week-end. Speaking at Henleaze, Bristol, last Saturday, Sir Walter Monckton, the Minister of Labour, laid particular stress on the extent to which overseas buyers had been cancelling their orders owing to the strike situation. He said that the export trade in cement, motor cars, motor cycles, bicycles, tractors, agricultural machinery and electrical equipment had already been adversely affected. There were, too, some sources abroad from which British industry might reasonably have hoped to obtain orders and was not getting them. It was important that the probable effect of strikes on the nation's export trade should be widely understood.

There was no quick answer or simple solution to the problems posed by the dock strike. It was not possible just to pass a new law and so put an end to the trouble. Peace in industry depended, as it often did in other spheres, not so much on legislation as upon the spirit operating among the men concerned. In industry, much depended upon the maintenance of good human relations between managements and workpeople. An appeal should be made to all men and women of good will to do their utmost individually to assist the country to obtain prosperity and security. It should be clearly emphasised that there would be fair shares for all, but that peace and prosperity must come first. If this were done, people would respond.

At Neston, Cheshire, Mr. Selwyn Lloyd, the Minister of Defence, said that the cheerfulness with which industry and the public had faced the railway strike should not be allowed to blind anyone to the essential seriousness of recent disputes. The full cost of the dock strike, in particular, would only become apparent after a time, when an adequate assessment could be made of its effects. Unfortunately, some of its repercussions on Britain's overseas markets were likely to be permanent. The motor-car industry had had to curtail its overseas shipments very substantially, and the export of bicycles had likewise been badly affected. The importation of raw materials, also, had been delayed. Shortages of foreign ore which might soon arise in the steel industry would have to be compensated for by extra imports later in the year. Britain's position as a clearing-house for foreign goods had suffered, and all these things were bound to have serious repercussions on the country's balance of payments.

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WORK STUDY FOR COAL

For some time now a work study department has been working at the headquarters of the National Coal Board. A time and motion study expert was seconded from his firm to instruct some of the Board's engineers and a number of such men have now been trained at area level. In South Yorkshire and the East Midlands, time and motion study has already begun. Care is being taken to fit the work into a general pattern aimed at introducing other modern management techniques into the mines, including an effort to obtain maximum co-operation from the union by inviting its representatives to lectures held for mining officials.

Sending stop watches into the coalfields is an imaginative and courageous step. The success of such a move will call for the maximum of tact and patience. As would be expected, a start has been made with surface work at the pits. The real test will come when the watches go underground. There, the independence of the miner is at its greatest and the influence of the mine manager (if for no other reason than the distance from the pit head) at its weakest.

In a sense, those responsible for this innovation can afford to make haste slowly. The opportunities for better results which might come from systematic time and motion study are not confined to coal cutting and conveying underground. The case for time and motion study might be won on the surface if it can be shown there that results improve and that the men share in that improvement.

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AGREEMENT ON IRRIGATION

A major step forward in economic co-operation between India and Pakistan took place last week when an inter-governmental agreement was signed by those countries' delegations now in Washington. The two delegations are engaged in the preparation, in co-operation with the International Bank for Reconstruction and Development, of a comprehensive plan for the irrigation of the waters of the Indus system of rivers. The agreement makes provision for additional canal withdrawals by India from the three Eastern rivers of the Indus system—the Ravi, Beas and Sutlej—in replacement for the use by Pakistan of waters from the Western rivers of the system—the Indus, Jhelum and Chenab. The International Bank's announcement makes no reference to the World Bank's proposal last July for a complete division of the Indus waters between the two countries: the Western rivers to Pakistan and the Eastern to India. This scheme (see Weekly Survey, July 23, 1954) was rejected by Pakistan and apparent deadlock reached in the negotiations that began in May, 1952. The new agreement now makes possible further progress towards an effective scheme for the full utilisation of the waters and, in the words of the Bank, "enables the Indian and Pakistan Delegations to continue to work, with the participation of the International Bank, on the preparation of the comprehensive plan, in an atmosphere of co-operation and goodwill."

The lowering of the political barriers to economic achievement in the Punjab should give considerable satisfaction to the British engineers who planned the Bhakra Canal system that was opened last year. The vast scale of achievement possible once the division of the Indus waters has been agreed should bring considerable benefits to both Pakistan and India, and should open up new markets for the services of British civil engineers and for British engineering products.

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FINDING THE FUEL

The impending shortage of coal is one of the principal reasons for undertaking the large programme for nuclear power production in the United Kingdom. By 1960, coal consumption in British power stations will have increased by about 13 million tons per annum. Already the proportion of requirements met from imported supplies is far from insignificant (2·2 million tons last year) and, as Mr. J. Eccles has said in his paper, "The Generation of Electricity—British Electricity Authority (10-year forecast)," the gap between available supplies of home coal and those required for electricity consumption will widen progressively. In fact, the ceiling for home coal supplies may never exceed 60 million tons.

Since, despite the large programme, nuclear power will be able to provide only about one-fifth of total British requirements by 1975, C.E.A. still face the necessity of finding adequate supplies of the conventional fossil fuels at reasonable cost. The development of plant to make the best use of low-grade coals will help, but will not counteract the effect of rising prices and uncertain supplies. Increasing attention has, therefore, been given to the possibility of using more oil. Several of the new power stations are scheduled for oil-firing and the Central Electricity Authority have recently signed a contract with the Esso Petroleum Company for the bulk supply of fuel oil. It is expected that a total of 24 million tons will be delivered over the next ten years at prices which compare favourably with coal. On a thermal basis, fuel oil has hitherto been somewhat more expensive than the coal purchased by C.E.A., but Esso have agreed to supply at prices which should work out at, initially, £5 a ton compared with standard fuel oil prices of £7 to £7 10*s*. per ton. As coal prices rise, the price paid by C.E.A. will be allowed to rise to the standard price of oil, and thereafter, as coal prices continue to rise, C.E.A. will have a price advantage in using oil. The quantity of oil used compared with coal will still be relatively small, but it will bring some welcome stability to the Authority's fuel supplies.

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PAYING FOR GAS

Gas and electricity price tariffs have always been based on different principles. The gas industry has hitherto preferred to charge a flat price per therm to all consumers regardless of the fact that it is uneconomic to supply those who consume less than 20 therms a quarter. One of the main arguments against following the example of the electricity industry and charging more heavily for the first block of units consumed than subsequent units has been the hardship which would be inflicted upon small consumers. A recent survey by the East Midlands Gas Board points out, however, that most of these are not poor or elderly persons but families well above the poverty line who have only one small appliance, usually a gas ring for occasional use. Such consumers could well afford to pay enough for their gas to cover their due share of overheads. Consequently, a "two-block" tariff is proposed under which the first block of 10 therms would be charged at 24·8*d*. per therm and all subsequent units at 12*d*. per therm. This would mean an extra 1*d*. a day for small consumers but it would restore effective competition between the gas and electric industries which is at present being stifled. With gas and electricity tariffs on similar principles, the running costs of the great majority of gas cookers would be lower than those of electric models and the running cost of all additional gas appliances used—fires, washing machines, etc.—would be 40 per cent. cheaper than their electric counterparts.

While the arguments in the survey appear to be conclusive enough from the narrower standpoint of introducing fairer and more effective competition between gas and electricity, it is perhaps a pity that the case was not related to the wider context of how the nation can make the best use of its fuel supplies. For example, is it desirable to encourage consumption of gas at the expense of electricity when coal supplies will become increasingly more difficult? The electrical industry has to expand capacity in order to meet the industrial load, and their two-block tariff system which encourages domestic consumption has the justification that it helps to balance the load. Admittedly, as the survey points out, such a tariff would help to balance the load on the gas industry, but in their case are essential industrial supplies proportionately as important? If not, there is less justification for the encouraging of domestic consumption for load balancing.

INTERNATIONAL BUILDING EXHIBITION AT PARIS

"CLAY BOTTLE" CONSTRUCTION TECHNIQUE

The first International Building and Public Works Exhibition is being held in the Bas Parc de St. Cloud, Paris, from June 25 to July 10. More than 300 companies from about twelve countries are represented, France and the other Continental countries naturally predominating, though both the United Kingdom and the United States are also represented. Though much smaller than the London Public Works Exhibition—and many of the stands were of the type more associated with the British Ideal Home Exhibition—the setting is particularly attractive, sited as it is in the open and in one of the finest parks on the western outskirts of Paris.

Emphasis at the exhibition, both with respect to materials and machinery, is on building for houses and housing estates, though such methods are, of course, easily adapted for lighter industrial purposes. With one or two exceptions—a heavy dumper truck that is electrically powered from an overhead trolley system, shown by Vétra, 79 avenue des Champs-Elysées, Paris, is a particular example—the plant is lighter and of a smaller capacity than that shown in London last November. Civil-engineering plant includes, however, ditchers, excavators, compressed-air tools and some mobile generator sets, but the best represented equipment in this section is handling plant for concrete and associated materials. Silos for bulk cement are much in evidence, as are small rail-mounted trucks, including some incorporating weighing mechanisms. Only one stand is devoted to prestressed concrete and the emphasis here is on sleepers for railways; two types predominate, a square pad and a longitudinal sleeper 3 m. long, both of which use metal ties between the rails to maintain the gauge.

Of novel building techniques displayed two are especially interesting, a prefabricated staircase that permits a sufficiently wide tolerance in dimensions to allow it to be easily fitted at site, and a structural method that employs a baked-clay "bottle" as the basic element.

The prefabricated staircase is of reinforced concrete and is shown by S.A.F.A., 29 rue Danielle-Casanova, Paris 1. It consists of the inclined beams to support the treads, the beams having rounded notches on the top side so that they will receive the prefabricated treads despite a fairly wide variation in the slope of the beams. The treads can be set truly horizontal and are finally grouted to make them secure.

The "clay bottle" technique was exhibited on the stand of the Centre de Recherches des Structures Naturelles, 128 Boulevard Haussman, Paris 8. The basis is a lightweight clay bottle of 12 in. overall length (10 in. effective) of 3 in. outside diameter and with ¼-in. walls; it weighs about 2¼ lb. By placing these bottles end to end, the neck of one bottle in the bottom of the next, a beam or column can be constructed that is similar in fashion to a bamboo stem. Such a beam may be straight, but the free fitting of successive bottles is sufficient to permit the construction of an arch or vaulted roof, so forming a permanent shuttering for a concrete covering. Without reinforcement, the bottles are claimed to form a self-supporting span of 30 ft. and this can obviously be extended by the use of plain or tensioned reinforcement. The "bottle" beams can be placed side-by-side to form slabs and may also be duplicated in layers to form heavier structures. The built-up slab is then given a surface of concrete inside and out—reinforced with wire mesh—and this can then be given a plaster or waterproofing coat as may be necessary. The advantages of the method are, of course, its light weight, the high speed with which the bottles can be erected, and the low heat conductivity due to the cavities that are left. Indeed, the sponsors have on occasion taken advantage of the continuous passages that are in the slabs to pump heated (or cooled) air through the walls of the structure, so obtaining a close control of the internal conditions. Applications already include houses and churches, industrial buildings such as warehouses and factories, as well as such structures as bridges and culverts.

Other materials at the exhibition include wood, aluminium and plastics, the applications of the latter being made to pipes, and to surfaces which require to be quickly washed. Finishes and renderings include high-gloss paints, glass fibre and glass bricks, the latter being shown by Saint Gobain, 20 avenue Montaigne, Paris. A large section of the exhibition is given over to surveying equipment, drawing instruments and office equipment generally. Throughout the period of the exhibition a series of conferences have been arranged, each devoted to a mechanical problem, such as corrosion in buildings or the use of a particular material, for example, wood or prestressed concrete. A number of visits have also been arranged to laboratories, factories and building sites in the Paris area.

The address of the organisers of the exhibition, which it is intended to make an annual event, is 28 rue Cambon, Paris 1.

ESCHER WYSS: 1805–1955

CELEBRATIONS OF THE OLDEST SWISS ENGINEERING FIRM

It is not an over-simplification to discern in the 150-year history of the famous Swiss engineering firm, Escher Wyss, Limited, a continuous thread in the application of fluid force allied to rotary motion. There are certain design principles which are common to several of their most important products—water, steam, and gas turbines, axial fans, turbo-pumps, compressors and blowers, marine propellers and industrial centrifuges. And the subject is not altogether unconnected with sluice gates, refrigerating machines, heat pumps, evaporators, cement-making machines, plant for the chemical industry, pipe-lines, and boilers and their auxiliaries, all of which Escher Wyss make. The continuous thread was tenuous in the early years of the firm, being represented only by water-wheels, but it can be followed throughout the whole of the period, even when they were building ships in the Nineteenth Century, with the Alps separating them from Switzerland's nearest sea outlet.

Escher Wyss have had many vicissitudes during those 150 years; more than once their fortunes have been at a low ebb. But happily the anniversary was celebrated last week in an atmosphere of prosperity, the firm welcoming friends from all over the world and entertaining them royally. On Monday, June 27, visitors toured the works at Zurich. The shops, offices and research laboratories revealed that orderliness which is so characteristic of Swiss engineering practice. Next day, hosts and guests set off to travel the length and breadth of Switzerland and see some of the power stations and plants, built or building, having Escher Wyss machines. Over the frontier into Germany one party visited the company's works at Ravensburg, where the closed-cycle gas-turbine plant embodying an air heater fired with pulverised coal is nearly completed.

62,800-H.P. FRANCIS TURBINES

From our personal experience we would say that tour "G" was second to none. The journey was by train through the Bernese Oberland to Martigny in the Rhone valley, and then a long climb by motor coach to see the Mauvoisin dam under construction, 6,450 ft. above sea-level. Of the two power stations visited which are fed from this reservoir, the Fionnay underground station is the most remarkable. It will employ the largest head so far used in a Francis turbine—1,500 ft. It is situated some distance down the valley and is reached by a tunnel cut through the rock in the side of the valley. There will be two vertical Francis turbines of no less than 62,800 h.p. each, although they are characteristically compact.

From Fionnay, water will flow to a compensation basin nearby, and from there it will pass through the mountain to two penstocks running down to Riddes power station in the Rhone valley. Here there will be five Pelton wheels of 68,000 h.p. each.

The dam is still in the early stages of construction. During the summer about 1,000 men are employed. They are housed in a village built for them just below the site. From mid-November to mid-April, however, only about 300 are retained on the site. The catchment area at Mauvoisin is being artificially increased by means of two galleries cut through the mountains on both sides of the valley and connected to several minor catchment areas.

Escher Wyss are supplying the turbines for these two power stations, thus adding to the several hundred machines of their make which are already in service. A comprehensive review of their work in this field, and of design and production considerations, was given in vol. 25-26 of the *Escher Wyss News*. This publication, which is available in an English edition, also dealt with pumps, valves and pipe-lines.

The 150th anniversary of the firm—stated to be the oldest engineering firm in Switzerland—was formally celebrated at a luncheon at the Kongresshaus, Zurich, on June 27, when the President, Herr P. Schmidheiny, received the guests. The history of the firm was recalled in a special book prepared for the occasion. Hans Caspar Escher (1775-1859) was led to found the firm as a result of his interest in the early spinning machines. He designed one in the cellar of his parents' house, and in 1805, with the financial help of several friends including the banker Salomon Wyss, he established a spinning mill. In due course the mechanical engineering department of the business prospered, especially as Escher's only son, Albert, applied himself to managing it. Unfortunately the son died in 1845, and when the father died 14 years later there was no one obviously fitted to take over the management.

Names which stand out in the subsequent history of the firm include Henry Zoelly, of steam-turbine fame, and above all Colonel Jacob Schmidheiny, who pulled the firm through the great difficulties of the 1930's. Colonel Schmidheiny died a few months ago, on January 8, 1955, and it is his son who has succeeded him in presiding over Escher Wyss. To-day the firm is alive to modern developments and opportunities. In the research department some valuable new apparatus is being installed which will enable further advances to be made in the design of all those machines in which fluid force is allied to rotary motion.

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R.S.I. MUSEUM RECONSTRUCTION

The Royal Sanitary Institute, 90 Buckingham Palace-road, London, S.W.1, announces that for reconstruction and modernisation the Institute's Museum of Health will be closed from August 1, 1955.

The official re-opening date is expected to be in the spring of 1956.

Letters to the Editor

DRIVING HEADLESS RIVETS

Value of a Temporary Plastics Collar

SIR, Suggestions have been made from time to time* for the use of headless rivets or driven pins for the assembly of riveted structures. It has been shown that they are sound in principle and have adequate strength for many purposes. Their chief advantages over conventional rivets are the reduced driving force required and economy because less metal is used.

One of the difficulties, however, of using lengths of rod in place of rivets is to locate the rod with respect to the plates during the initial stages of driving, as it is free to move axially until it has swelled sufficiently to fill the hole. This difficulty can be overcome by the use of a plastics collar cast or fitted on to one end of the length of rod to act as a temporary rivet head. The collar should be of such a nature as to hold the rivet in position for driving until hole filling is completed, after which vestigial heads are formed on the rod, causing the collar to shatter and part from the bar stock. Initially an epoxide-type casting resin was used for the collar and proved to be successful in meeting these requirements, but there is a very wide range of plastics which are suitable for temporary heads on bar stock. Further successful tests have been carried out with P.V.C. tubing, casein resins and the epoxide casting resins with varying amounts of added fillers. The composition and mechanical properties of the plastics are not critical; in many tests as much as 50 per cent. slate flour had been added to the casting mix. The cost of such plastics heads is considerably less than that of normal manufactured heads.

* J. G. Whitman, "Structural Light-Alloy Riveting with the High Tensile Alloys." *Engineer*, vol. 192, page 228 (1951); and D. A. Barlow, "Aluminium-Alloy Headless Rivets," ENGINEERING, vol. 177, page 398 (1954).

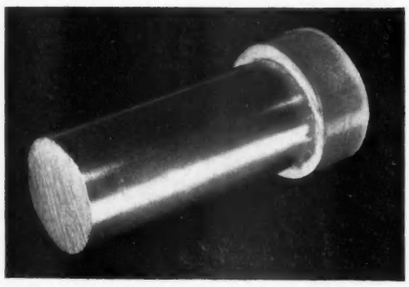

Fig. 1 A temporary plastics collar fitted to a 1-in. diameter bar for riveting. Such collars are cheaper than the conventional manufactured heads but are adequate to prevent axial movement of the bar until it fills the hole; furthermore, a reduced driving force is required as compared to that for conventional headed rivets.

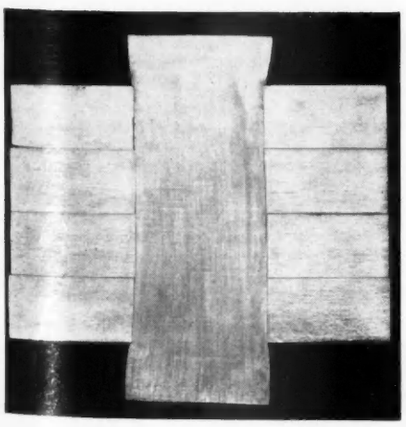

Fig. 2 Section through the riveted joint made by driving 1-in. diameter bar in $1\frac{1}{32}$-in. diameter holes. The formation of the vestigial heads is sufficient to shatter the collar, which is then easily removed.

The accompanying illustrations, Figs. 1 and 2, show typical rivets of this type before and after driving. The rivets, 1-in. in diameter and of H10-W alloy, were driven in $1\frac{1}{32}$-in. diameter holes in H15WP alloy plate, 2 in. thick, using a Broom & Wade standard 25-ton hydro-pneumatic portable squeeze riveter (the largest size normally made). The collar end of the rivet was placed on the fixed arm of the squeezer.

Headless rivets, 1 in. in diameter, in the usual aluminium rivet alloys, are well within the capacity of this machine. For comparison, the maximum size for snap-point rivets is $\frac{1}{2}$ in. diameter and for the small points in B.S. 1974 about $\frac{3}{4}$-in. diameter. Using headless rivets the range of portable squeeze riveting can thus be extended considerably and much of the expensive and difficult gun driving on site eliminated, with the added advantage that there is no danger of incomplete hole filling due to faulty driving. Flat snaps were used here for convenience, but there is no reason why the snaps should not have a slight rim to give a rounded edge to the heads and so improve their appearance.

Plastics heads can also be used when it is desired to drive normal rivet heads and points from bar stock, provided that the snaps used are of open design to avoid trapping the fragments of the plastics.

Yours faithfully,
P. G. BARRETT.

Aluminium Laboratories, Limited,
Banbury, Oxon.
June 14, 1955.

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ATOMIC WASTE

Caesium 137 for Radiotherapy

SIR, In an article on page 782 of your issue of June 24 it is implied that the use of caesium 137 for radiotherapy is a distant prospect. In fact, a machine for this purpose, designed and built jointly by the Royal South Hampshire Hospital and this Department, is now nearly complete and is to be shown at the forthcoming exhibition at Geneva. The machine is expected to be in normal use by the end of the year.

It is hoped to publish in the near future descriptions of this apparatus from both the medical and engineering points of view.

Yours faithfully,
A. N. BLACK,
Professor of Mechanical Engineering.

The University,
Southampton.
June 30, 1955.

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LIGNUM VITAE

Early Use in Stern-Tube Bearings

SIR, The following extract from an address given by the late Engineer Captain Edgar C. Smith, O.B.E., to the Staff Association of Lloyd's Register of Shipping may be of interest to your correspondent (issue of June 24):

"Perhaps the most interesting chapter in early marine engineering history is that relating to screw propulsion. There were scores of patents relating to screw propulsion, and the ideas of how a screw for a ship should be made, where it should be placed, and how it was to be driven, do credit to the fertility of the human mind. Like other innovations, the screw brought in its train several difficult problems. In the first place, the screw shaft had to revolve much faster than a paddle shaft, and it was essentially the day of low speeds of revolution. Secondly, there was the problem of where and how to take the thrust of the propeller shaft, and in old note-books you come across such terms as "pushing bearings" and "pushing posts," and, thirdly, there was the design of the bearing where the wrought-iron stern shaft passed through the stern post. The stern tube bearing was perhaps the most difficult problem of all, and so long as marine engineers clung to brass bearings there was always trouble, and this trouble had much to do with some shipowners preferring to stick to paddle wheels. It was John Penn, of Greenwich, who introduced the lignum-vitae bush, and records of his experiments are to be found in two papers contributed to the Institution of Mechanical Engineers in 1854 and 1856, respectively."

Yours faithfully,
J. M. MURRAY.

Lloyd's Register of Shipping,
London.
June 24, 1955.

Editor's Note: Of the letters received on this subject this from Mr. Murray is published as being of general interest.

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OIL FILM EXTENT IN COMPLETE JOURNAL BEARINGS

Occurence of Cavitation Erosion

SIR, We are interested to note that Mr. E. A. Ryder, in your issue of July 1, page 5, considers the planet-wheel bearings in epicyclic gears to be subject to cavitation erosion, as there have been few cases where this form of damage has been definitely recognised. There is always the possibility that what appears to be cavitation erosion is in fact a surface fatigue effect due to the compressibility of oil forced into the bearing surface pores at the maximum film pressures.

In the case of the steadily loaded bearing dealt with in our article (issue of April 29), the transition from the cavitated film to the pressure generating complete film is gradual, so that cavitation damage produced by the sudden collapse of vapour bubbles seems unlikely. The dynamically loaded bearing, such as the planet-wheel bearing instanced, is more likely to suffer from true cavitation erosion, since the film pressure at any point fluctuates rapidly between the maximum and minimum values. We are at present preparing to investigate conditions in a dynamically loaded transparent bearing, but the maximum load on our glass bushes is at present limited to 200 lb. per square inch, which is perhaps only a quarter of the loading with which Mr. Ryder is concerned.

The two relieved-bush photographs in the article may have been misleading in that both show a complete outlet film. In general the position and form of the oil inlet do not greatly influence the angular extent of the full-width film, and film cavitation at larger eccentricity ratios is inevitable. However, with the relieved bush operating at lower eccentricity ratios the film break-down position falls inside the relieved area and then even at low feed pressures the outlet film does not cavitate. Under dynamic loading, the oil reservoir effect of the relieved area may be useful, and could be obtained by putting the relief (a flat) on the outer side of the planet journal. Incidentally it would be interesting to learn whether in Mr. Ryder's application white-metal is applied to the journal or to the bush, as the former seems more appropriate to the type of loading involved.

No doubt a high feed pressure would be desirable, but this presumably is a matter of difficulty since oil is normally passed to the planet bearings via the planet carrier bearing and drillings in the planet carrier. Although a centrifugal supply head is thereby produced, the hydraulic resistance of the oil-way system must be considerable.

Yours faithfully,
J. A. COLE.
C. J. HUGHES.

Lubrication Division,
Mechanical Engineering Research Laboratory,
Thorntonhall,
Glasgow.
June 24, 1955.

PERSONAL

SIR HAROLD WEST, J.P., has announced his intention to retire as managing director of Newton, Chambers & Co., Ltd., Thorncliffe, near Sheffield, in the spring of 1956. MR. P. J. C. BOVILL, an assistant managing director and general manager of the chemicals division of the company, has been elected a member of the board, with effect from July 1, with a view to his eventually succeeding Sir Harold as managing director.

The diploma of honorary membership of the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2, was presented to H.R.H. THE DUKE OF EDINBURGH, K.G., K.T., F.R.S., at the Palace of Holyrood House, Edinburgh, on July 1.

SIR FREDERICK E. REBBECK, K.B.E., D.Sc., D.L., J.P., and MR. GILBERT J. INNES have retired from office as joint chairmen of the Technical Committee of Lloyd's Register of Shipping, 71 Fenchurch-street, London, E.C.3, and SIR PHILIP B. JOHNSON, B.A., and MR. CHARLES CONNELL, M.A., have been elected the new joint chairmen, as from July 1.

SIR JOHN GIBSON GRAHAM, M.C., has been appointed the Ministry of Transport and Civil Aviation freight-market representative, in succession to the late MR. H. O. ROBERTS, C.B.E. Sir John took up his appointment on July 1.

MR. T. WATSON, a director of General Refractories Ltd., Genefax House, Sheffield 10, has been elected President of the Refractories Association of Great Britain for the ensuing year.

PROFESSOR A. J. MURPHY, M.Sc. (Manc.), F.I.M., for the past five years Professor of Industrial Metallurgy at the University of Birmingham, and, since 1953, director of the Departments of Physical Metallurgy and Industrial Metallurgy, has been appointed Principal of the College of Aeronautics, Cranfield, Bletchley, Buckinghamshire.

SIR MAURICE DEAN, K.C.M.G., C.B., hitherto a Second Secretary in the Board of Trade, took up the appointment of Permanent Under Secretary of State for Air on July 6. SIR HENRY GREGORY, K.C.M.G., C.B., who has been a Second Secretary in the Board of Trade since 1949, retires from the public service on July 16. MR. G. H. ANDREW, at present an Under Secretary in the Board of Trade, has been appointed a Second Secretary, and the other vacancy will be filled by the transfer to the Board of MR. L. H. ROBINSON, C.B., at present a Second Secretary in the Ministry of Supply.

Honorary membership of the American Society of Mechanical Engineers has been conferred upon DR. D. W. BRONK, President of the National Academy of Sciences; MR. R. E. HEARTZ, President, Engineering Institute of Canada; MR. H. V. TORNEBOHM, vice-president of the SKF Co., Gothenburg, Sweden; SIR VINCENT DE FERRANTI, M.C., M.I.E.E., chairman and managing director, Ferranti Ltd.; MR. E. F. MERCIER, a French industrialist; and PROFESSOR JACOB ACKERET, of the Federal Polytechnic Institute, Zürich, Switzerland.

MR. KENNETH C. BARNABY, O.B.E., B.Sc., A.C.G.I., M.I.N.A., M.I.Mar.E., who has been naval architect to John I. Thornycroft & Co. Ltd., Southampton, for 31 years, retired on June 30, but is to continue to serve the firm in an honorary consultative capacity. He has been succeeded as naval architect by MR. D. R. TODD, M.I.N.A., hitherto chief draughtsman and assistant naval architect.

MR. S. A. FINNIS, chief docks manager, Humber Ports, British Transport Docks Division, has been appointed a member of the Transport Users Consultative Committee for the Yorkshire area.

MR. W. ARMSTRONG, of Armstrong (Leeds) Ltd.; MR. L. L. BOTT, of Davey, Paxman & Co. Ltd.; MR. J. O. BOWLEY, of A.E.C. Ltd.; MR. J. W. GARTON, of the Hoffmann Manufacturing Co. Ltd.; MR. A. GRIFFITHS, of F. Perkins Ltd.; MR. G. L. HACK, of the Bristol Aeroplane Co. Ltd.; MR. I. T. MORROW, of the Brush Electrical Engineering Co. Ltd.; MR. J. B. STEVENSON, of E.M.I. Factories Ltd.; and MR. R. WONFOR, of Powers-Samas Accounting Machines Ltd., have been elected new members of the Council of the Production Engineering Research Association of Great Britain, Melton Mowbray, Leicestershire.

MR. C. D. P. SMALLPEICE, the chairman, and MR. G. GODWIN, have been appointed joint managing directors of Martonair Ltd., Parkshot, Richmond, Surrey. MR. R. C. CARTWRIGHT has been made director and secretary and Mr. C. KIRK technical director.

MR. LEWIS CHAPMAN, C.B.E., is retiring from the position of managing director of William Jessop and Sons Ltd., and J. J. Saville & Co. Ltd., on completion of 50 years of service with the B.S.A. Group steel interests. He has been appointed chairman of Jessop-Saville. MR. R. P. WALLACE, who has been associated with Jessop-Saville for over 20 years, has been appointed managing director from August 1. MR. F. WARDROBE, A.M.I.E.E., who has had a very long connection with the steel interest of the Group, has resigned at his own request from the board of Jessop-Saville, as from August 1, but has consented to remain available as engineering consultant.

DR. W. J. STRANG has been appointed chief designer, fixed-wing aircraft, of the Bristol Aeroplane Co. Ltd., Filton House, Bristol. He, with MR. R. HAFNER, chief designer, helicopters, and MR. D. J. FARRAR, chief designer, guided weapons, will be responsible to DR. A. E. RUSSELL, who relinquishes the title of chief designer and assumes that of chief engineer, aircraft division.

DR. J. W. BARRETT, B.Sc., D.I.C., F.R.I.C., A.M.I.Chem.E., has been elected a director of Monsanto Chemicals Ltd., 8 Waterloo-place, London, S.W.1. He will continue to be responsible for the company's research and development activities.

DR. G. G. MEYERHOFF, M.Sc. (Eng.) (Lond.), A.M.I.C.E., A.M.I.Struct.E., has been appointed Professor of Civil Engineering at the Nova Scotia Technical College, Halifax, Nova Scotia, Canada.

MR. D. MCDONALD, B.Sc., A.M.I.E.E., has received the triennial award of the Coopers Hill War Memorial Prize and Medal, made by the Council of the Institution of Electrical Engineers, for his paper, "The Electrolytic Analogue in the Design of High-Voltage Power Transformers."

MR. C. R. MAYO, M.I.C.E., M.I.Mech.E., M.I.Loco.E., has asked us to state that any further communications for his firm, Fox and Mayo, consulting engineers, or himself, should now be sent to him at Dennel Hill, Tidenham Chase, near Chepstow, Monmouthshire.

MR. R. H. HEMMENS, having retired from the British Petroleum Co. Ltd., has joined the Sheffield Twist Drill and Steel Co. Ltd., Summerfield-street, Sheffield 11, as London office manager, as from August 1, at Terminal House, Lower Belgrave-street, S.W.1.

MR. D. G. WELTON has left the Stoke-upon-Trent sub-office of the English Electric Co. Ltd., Stafford, to take up an appointment in the London Branch office of the company. MR. R. EDWARDS, previously at the firm's Birmingham branch office, has now taken charge of the Stoke-upon-Trent sub-office.

C.A.V. Ltd., Acton, London, W.3, announce that MR. J. J. BROWN, whose headquarters are at the firm's branch at 51 Upper Library-street, Belfast, has been made area sales manager covering both Eire and Northern Ireland. MR. R. J. HALE is now senior service engineer for both territories, while MR. H. DRAPER will act as service engineer, attached to the Dublin depot, at Portland-street North, North Circular-road, Dublin.

MR. GEORGE DOW, M.Inst.T., A.I.Loco.E., for the past six years public relations and publicity officer of British Railways, London Midland Region, moved to the chief commercial manager's department at Euston House, London, N.W.1, on July 1 as chief assistant (sales). This is a new post created for the development of passenger and freight business in the Region.

GROUP CAPTAIN A. F. BANDIDT, A.R.Ae.S., R.A.F. (ret.), assistant sales manager of Handley Page Ltd., Cricklewood, London, N.W.2, has been appointed the company's representative in Australia, New Zealand and the Far East. From the autumn of the present year he will be based in Melbourne.

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COMMERCIAL

THE AVELING-BARFORD Group of Companies, Grantham, have formed a new subsidiary company, AVELING-BARFORD AFRICA (PTY.) LTD. This commenced operations on July 1 from the head office in Johannesburg. Branch offices in Cape Town and Durban opened at the same time, to be followed on August 1 by a third branch office in Salisbury, Southern Rhodesia. The Group have purchased a controlling interest in the engineering firm, MESSRS. E. W. GRAY (PTY.) LTD., Steeledale, Johannesburg, in whose premises the new company's head office is situated.

The address of the Glasgow office of BURTON, GRIFFITHS & CO. LTD., Mackadown-lane, Kitts Green, Birmingham 33, has been changed to 135 Wellington-street, Glasgow, C.2. (Telephone: Central 0021-2.) MR. J. S. COCHRANE remains the branch manager.

A company, FIBROMOLD LTD., has been established as fabricators of resin glass laminated structures. The chairman is MR. ROY SIEMSSEN and the managing director, MR. CHARLES MEISL, and the temporary address, Old Manor Cottage, Send Marsh, Ripley, Surrey. A new factory has been erected at Hanworth-lane, Chertsey, and production is scheduled to commence early in August.

THE VACUUM OIL CO. LTD., Caxton House, London, S.W.1, have formed a new South Wales Industrial Division, which came into operation on July 1 with headquarters in Cardiff. The divisional manager is MR. A. PECK.

BORG-WARNER, LTD., are building a new factory at Letchworth, Hertfordshire, for the production of internal-combustion engine transmissions, semi-automatic overdrives and other components for the motor-car industry.

HUNTING-CLAN AIR TRANSPORT LTD., 72 Wigmore-street, London, W.1, are to inaugurate "all-cargo" air services between the United Kingdom and most parts of Africa on July 23. On that day a specially-adapted four-engined Avro York freighter aircraft will leave Manchester and London for East Africa.

THE COLOMBIAN AIR LINE, SOCIEDAD AERONAUTICA MEDELLIN (S.A.M.) and K.L.M. ROYAL DUTCH AIR LINES are forming a new company to develop passenger traffic in Colombia, South America. The new company will be known as RUTAS AEREAS S.A.M.

BROOK MOTORS LTD., Empress Works, Huddersfield, who, for many years, have manufactured alternating-current electric motors up to 250 h.p., have now extended this range to a maximum of 500 h.p., ventilated and 350 h.p. totally-enclosed in both cage and slip-ring types.

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CONTRACTS

Railway Traction Control Equipment. The 34 all-steel coaches just ordered by the Toronto Transit Commission from the GLOUCESTER RAILWAY CARRIAGE AND WAGON CO. LTD., will be equipped as before with electro-pneumatic camshaft control equipment supplied by the BRITISH THOMSON-HOUSTON CO., LTD., Rugby. As stated in our first reference to this order, on page 783 of our issue of June 24, the present order for 34 cars follows the satisfactory operation of the coaches which first went into service in March, 1954.

Coal Mine Cars. A subsidiary company of Sheepbridge Engineering Ltd., Chesterfield, SHEEPBRIDGE EQUIPMENT LTD., have received an initial order for some of their mine cars from the National Coal Board for the Cynheidre New Colliery, in the South-Western Division. The Cynheidre colliery is a new project and part of a large organisation scheme for the Welsh coalfields. It is understood that the total requirement of mine cars for the new colliery will be between 2,000 and 3,000.

Air Liners. A contract for the purchase of three Bristol Britannia 300 LR turbo-propeller air liners has been placed by El Al Israel Airlines with the BRISTOL AEROPLANE CO. LTD., Filton House, Bristol. The aircraft are to be delivered for operation early in 1957. They will be capable of flying a scheduled non-stop London-New York service, from both east and west, all the year round. The power unit is the Proteus 755 engine which gives 4,120 equivalent horse-power. The interior layout of the aircraft provides for two compartments, accommodating a total of 93 passengers. The Britannia 300 LR carries a maximum pay-load of 28,000 lb. over 4,600 miles (still air range) and its true mean cruising air-speed is 385 m.p.h.

Air-Compressor Plant. The Ministry of Works have placed a contract with the GENERAL ELECTRIC CO. LTD., Magnet House, Kingsway, London, W.C.2, for air-compressor plant of 350,000 h.p. The equipment is for extensive new Government research and testing facilities and comprises centrifugal compressors having a combined turbine and synchronous motor drive.

Rolling-Mill Drive. An order for rolling-mill plant has been received by the BRITISH THOMSON-HOUSTON CO., LTD., Rugby, to replace one of their older machines which has already done 36 years of service. In 1919 the firm supplied to Steel, Peach and Tozer of Sheffield a 6,000-h.p. reversing cogging-mill drive. Some years ago the rolling mill driven by this motor was completely modernised but the old drive was retained. During its long service it has been working 24 hours a day, 5½ days a week and is still in satisfactory running condition. It has been decided, however, to replace the old by a completely new drive. The horse-power has been increased to 7,000 and the new motor will go on the same baseplate as the old.

The full rating of the new motor is 7,000 h.p., 50-100 r.p.m., 1,500 volts, with a cut-out rating of 21,000 h.p. The motor-generator set being supplied with it has a 5,000 h.p. induction motor, three 1,867-kW, 500-volt generators and a 30-ton flywheel. The control gear will be capable of very high rates of reversal.

Helicopters. British-built helicopters are to be used for the first time in connection with off-shore oil-drilling operations in the Persian Gulf. The Royal Dutch Shell Group have placed an order for two S-55 helicopters with WESTLAND AIRCRAFT LTD., Yeovil, Somerset. Each will be equipped to carry eight passengers in addition to a crew of two, and will be fitted with floats to enable landings to be made on the sea in case of emergency. The helicopters will be used to fly crews and supplies from shore bases to drilling rigs which may be as much as 70 miles out to sea. The machines will be operated on behalf of the Royal Dutch Shell Group by Bristow Helicopters Ltd. The first helicopter is scheduled for delivery in August and the second in October.

Chemical Plant. British Petroleum Chemicals Ltd., which commenced operations at Grangemouth in 1951, have placed orders for new plants which will double the make of olefines and diversify the list of petroleum chemical products made. It has been decided to build cracking and gas separation plants and a synthetic-alcohol plant which are essentially duplicates of the existing equipment. A new unit, treating another stream from two gas separation plants, will extract butadiene, and another innovation will be the production by catalytic means of a polymer of propylene. The main contracts have been placed with the STONE AND WEBSTER ENGINEERING CORPORATION for the main extensions, and with the KELLOGG INTERNATONAL CORPORATION for the butadiene plant. These main contractors will sub-contract a large majority of the field work to a number of British contractors. With a few specialised exceptions, all the new plant and equipment will be purchased and fabricated in the United Kingdom. The cost of the work is expected to be over £8 million and the new units are scheduled to be commissioned by the first half of 1957.

Compasses. A large order has been received by the SPERRY GYROSCOPE CO. LTD., Great West-road, Brentford, Middlesex, from Switzerland, for Gyrosyn compasses. These instruments will be used in DE HAVILLAND VENOM aircraft of the Swiss Air Force, which are to be built under licence in Switzerland. The compasses, however, are to be manufactured in this country.

Air Liners. An order for two Viscount 800 series propeller-turbine air liners has been placed by Transair Ltd., British independent air-transport operators, with VICKERS-ARMSTRONGS LTD., Vickers House, Broadway, London, S.W.1. The delivery of the aircraft is scheduled for mid-1957.

Fork-Lift Carriers. MATERIALS HANDLING EQUIPMENT (GREAT BRITAIN) LTD., 7, Chesterfield-gardens, Curzon-street, Mayfair, London, W.1, announce that, as sole concessionaires, they have received a contract for supplying IRION side-operating fork-lift carriers to the British Transport Commission for handling and transporting long heavy loads of timber, steel and other products in the wagon and locomotive-building and repair plants of British Railways.

Atomic Power Supply System. Contracts for extensions to this country's atomic power supply system, amounting to several million pounds sterling, have been placed with BABCOCK AND WILCOX LTD., Babcock House, Farringdon-street, London, E.C.4. This firm supplied the steam plant for the original station at Calder Hall and the new contracts cover what, in effect, are three new plants similar to Calder Hall. Eight steam towers each 80 ft. in height will be supplied to a new station to be known as Calder Hall "B." Two further installations totalling 16 towers, will be supplied to a power station at Chapelcross, near Annan in Dumfriesshire.

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OBITUARY

We regret to record the deaths of:

MR. JOSEPH ROBERT MAGEE, at Giffnock, Glasgow, on June 16. For the past 12 years Mr. Magee had held the position of technical representative, in Scotland, of Armstrong Whitworth (Metal Industries) Ltd., Close Works, Gateshead-upon-Tyne 8.

MR. RICHARD HENRY STEPHENSON, O.B.E., at Corbridge, Northumberland, on June 27 at the age of 71. Mr. Stephenson retired nine months ago from the board of Smith's Dock Co. Ltd., North Shields, after 54 years in the North-East shipbuilding and ship-repairing industries. He served his apprenticeship with William Gray & Co. Ltd., West Hartlepool, and became assistant manager to Smith's Dock Co. in 1908. Twelve years later he was appointed general manager and, in 1928, was elected a director of the firm. He was awarded the O.B.E. in 1918 for his services to the shipbuilding industry.

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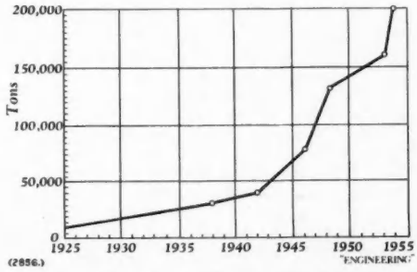
CAREERS AND EDUCATION IN PLASTICS

The nature of the plastics industry and the opportunities it provides for careers are probably not generally known. A booklet published recently by the Plastics Institute (The Adelphi, Adam-street, London, W.C.2) divides the industry into six sections: plastics materials manufacturers, moulders, fabricators, extruders, laminators and others, and plant manufacturers. The industry has grown rapidly, since the war, as is shown by the graph below.

Entry into it is either directly in a junior capacity in an office, works, or laboratory, coupled with part-time study; or through full-time technical college study; or by first taking a university degree. Among the examinations and qualifications which may fit a person for service in the industry are the City and Guilds Certificates in Technology of Plastics leading to the Diploma of the Plastics Institute; the Ordinary and Higher National Certificates in Chemistry or Engineering; the Associateship of the Plastics Institute, the Royal Institute of Chemistry, or the Institute of Physics; an Associate Membership of the Institutions of Mechanical, Electrical, or Chemical Engineers. Holders of a university degree in Science, Engineering, Arts or Commerce are advised to take a part-time course in plastics technology on entering the industry.

Firms connected with the plastics industry support a Plastics Industry Education Fund, which makes grants, etc., for education. The organisers of the Fund have recently appealed to firms to increase their support, since it has been found that the total annual income of about £5,000 is not sufficient, after the deduction of expenses, to finance all the schemes which are considered necessary. So far, the income has been spent on (1) training grants to students at universities and technical colleges who are studying full-time for first degrees or equivalent qualifications; (2) bursaries for full-time students at the Borough Polytechnic, London, studying for the Diploma of the Plastics Institute; (3) scholarships for full-time students at the College of Technology, Birmingham, studying for the Associateship of the Plastics Institute; (4) monographs on plastics technology; (5) grants for the purchase of capital equipment at technical colleges; (6) contribution towards the cost of an exhibition of plastics at the Science Museum; (7) books for the Plastics Institute libraries; (8) administration and other miscellaneous charges.

Grants have been made to both men and women and it would seem that there will be no lack of opportunity for new entrants to the industry in the future.



Graph showing the rapid increase in the tonnage of plastics materials produced in the United Kingdom.

THERMAL EFFICIENCIES OF BRITISH POWER STATIONS

A Continued Improvement

The Central Electricity Authority announce that the overall thermal efficiency of their steam stations during the year ended March 31, 1955, was 23·85 per cent. compared with 23·22 per cent. during the previous twelve months. This represents a saving of over 750,000 tons of coal and nearly £2¾ million in cost.

Of over 68,860 million kilowatt-hours sent out from these steam stations during this period more than one quarter was provided by the 20 most efficient stations. These stations had an average efficiency of 28·74 per cent., the individual figures being set out below.

Station	Thermal efficiency, Per cent.
Portobello, high pressure, Edinburgh	31·42
Stourport, low pressure, Worcestershire	30·83
Littlebrook B, Dartford, Kent	30·49
Dunston B.II, Newcastle-upon-Tyne	29·74
Bromborough, Cheshire	29·15
North Tees C, Middlesbrough	29·05
Skelton Grange, Leeds	28·89
Brunswick Wharf, Poplar	28·70
Uskmouth, Newport, Mon.	28·66
Braehead, Renfrew	28·59
Barking C	28·48
Brighton B	28·40
Poole	28·31
Carrington, near Manchester	28·30
Keadby, Scunthorpe	28·28
Deptford East, high pressure, London	28·06
Littlebrook C, Dartford, Kent	27·93
Carmarthen Bay, Burry Port	27·88
Huncoat, Accrington	27·75
Battersea B, London	27·71

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CONTINUOUS MEDIUM-STRIP MILL, ROTHERHAM

Preliminary site work is now in progress on a continuous medium strip-mill project at the Rotherham works of the Steel, Peech and Tozer branch of the United Steel Companies Limited, Sheffield. To be known as the Brinsworth strip rolling mill, the plant will be situated on land on the opposite side of the Sheffield Road from the firm's main Templeborough works.

The mill is being supplied by the Loewy Engineering Company, Limited, and is designed to produce strip from 4 in. to 18 in. wide with a maximum thickness of ¼ in. down to a minimum of 0·042 in., in deep-drawing, mild, medium-carbon, razor and stainless-steel qualities. At first the Brinsworth strip mill will produce 3,000 tons of strip material a week, increasing gradually to 6,000 tons a week, which is the designed capacity of the mill.

Slabs for reduction in the mill will come from the Templeborough works, where existing plant is being modified for this purpose.

The estimated cost of the mill is £3,600,000.

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TRANSLATIONS OF GERMAN STANDARDS

The German Standards Committee (DNA), Berlin, W.15, Uhlandstrasse 175, and Köln, Friesenplatz 16, have published a catalogue, "Deutsche Normen in Fremdsprachen" (German Standards in Foreign Languages), in which are listed the numbers, dates of issue and titles of more than 600 German (DIN) standards which are available in translation. The majority are in English and Spanish, but some are also published in French and Portuguese. The catalogue may be obtained through Beuth-Vertrieb G.m.b.H., Berlin, W.15, and Köln, post free.

COLLECTIVE USE OF FARM MACHINERY

Avoiding Over-Capitalisation

Since 1939 productivity in British agriculture has risen between 47 and 50 per cent. The reasons for this advance and the possibility of further advances are discussed in a booklet published by the British Productivity Council.* This publication is one of a series which have been issued by the B.P.C. following up the reports written by teams which went to the United States of America to study productivity in different industries there.

The key to further increases in farm productivity appears to lie in the hands of those willing to pay stricter attention to methods of management. With the development of new husbandry practices brought about by large-scale mechanisation, the greater use of chemical fertilisers, improvement in seeds and stock arising from scientific research and so forth, British farmers have increasingly to face policy decisions on production closely approximate to those arising in other branches of industrial management. Although new techniques of management have done much to increase the efficiency of British agriculture during the past sixteen years, their use must become more intensive and widespread if a substantial reduction in production costs is to be achieved and the present level of output maintained or improved on. The use of reasonably detailed costing systems and the wider application of work study are likely to figure more prominently than hitherto in farm management practices.

Mechanisation of farming has been going on steadily for many years, and the past sixteen years have seen a rapid acceleration of the process. War-time necessity and the drift of labour away from the land have been the two main causes of the acceleration, and without the aid of the increased number of machines the large increase in food production would have been quite impossible. However, there is a widespread feeling that despite the results achieved the best use has not been made of the plant purchased. The Institute for Research in Agricultural Economics at Oxford University have stated in a report entitled "Livestock Products in the United Kingdom in 1953," that expenditure by farmers on machinery has increased by approximately 900 per cent. (from £15 million to £150 million) since before the war. To place this vast increase beside the overall increase in food production (53 per cent.) confirms the doubt that machinery is being used to the best advantage.

After discussing the increases in farm machinery by types, the review suggests various ways in which over-capitalisation in machinery can be avoided on small farms. The method most strongly advocated is the sharing by several farmers of expensive items, although it is recognised that in the uncertain climate of the British Isles this system may operate unsatisfactorily.

As an alternative to the co-operative ownership of machinery there are many advocates of the extension of contract services. The scope of contract services is increasing, but contractors always face competition from farmers themselves, and have difficulty in contracting for cultivation, because the work does not extend over a whole season.

The basic principles of good husbandry change little with the years, but the methods of carrying those principles into practice change as new techniques and machines are produced. The need for careful management becomes more and more important, and the economic purchase and use of machinery can make the difference between profit and loss on a farm. Undoubtedly those machines which can be adapted for use for as much of the year as possible are those which the farmer of today needs.

* *A Review of Productivity in Farming*. British Productivity Council, 21 Tothill-street, London, S.W.1. (1*s*. 9*d*.)

UNIVERSAL TRANSPORT AIRCRAFT

PROTOTYPE HANDLEY PAGE "HERALD" NEARING COMPLETION

Handley Page, Limited, Cricklewood, London, N.W.2, have announced that their four-engined civilian transport aircraft, the Herald, is expected to fly for the first time within a few weeks. Although a small project team began work on the Herald concept late in 1952, it was not until last year that detailed design of the aircraft began; thus the prototype has been built in little more than a year. A description of the Herald appeared in ENGINEERING in 1954 (vol. 178, page 350).

In making this known to the Press, Sir Frederick Handley Page, chairman and managing director of the company, said that a new stage in aeronautical history, which had been dominated by the military aspect for 50 years, had now been reached: the use of aircraft as a means of transport and transport only, as a substitute for buses and trains. The kind of aeroplane required for this purpose should be robust and straightforward to maintain, have a slow landing speed and an easy take-off, and be economical at its flying speed; in fact, it might be called a "workhorse of the air."

"TRANSPORT AT A PROFIT"

High speeds were necessary for military aircraft, but where the competitor was a train, a motor vehicle or an ox wagon, what was needed was a safe comparatively quick means of travelling from A to B at an economical price. It was expensive to lay down roads and railway tracks, and the ideal way to open up new country was by air traffic. It was with this in mind that the Herald had been designed, and no matter how rugged the conditions of service and how extreme the climate it would provide operators with a means of "transport at a profit."

On the same occasion, the company's sales manager, Group Captain R. C. M. Collard, enumerated various features of the Herald and explained why each had been incorporated. A tricycle undercarriage with a specially strengthened nose wheel had been selected to give ease of taxying and loading and also passenger comfort; the cockpit was provided with a good view to simplify flying in contact conditions; the controls were such that if necessary the aircraft could be flown by one man; and a high-wing design had been chosen so that the fuselage was near the ground to allow lorries to be backed into position for loading. In addition, the high wing permitted ample propeller clearance for operation on rough and stony airfields, and offered good visibility for passengers. Four engines were fitted to ensure increased safety in case of engine failure, and piston engines were chosen since their running costs were comparatively small. The cabin, which was simply a shell, was large and adaptable; and could accommodate 44 tourist passengers, a combination of freight and passengers, or freight alone. It was mildly pressurised for comfort and included a large door.

"BRANCH-LINE" SERVICE

The Herald had been designed on a universal basis to serve in an extensive range of circumstances and a wide variety of rôles. It was likely to be of particular value as a "branch-line" aircraft, a machine to carry goods and passengers from one isolated place to another in the remoter parts of the world. In Europe few people flew for short distances; the Herald was designed rather for those territories where flying was essential to the life of the community, for the continents of North and South America, Africa and Australasia.

Australian National Airways and Queensland Airlines in Australia, and Lloyd Aero Colombiano in South America had reserved Heralds for service on their routes and orders for 29 had already been received. Delivery of production aircraft was likely to begin late in 1957.

The Herald represents the results of a survey in which operators all over the world were asked their views and requirements. It has a single fin and rudder, is of all-metal stressed-skin construction, and is powered by four 870-h.p. Leonides Major radial engines made by Alvis Limited, of Coventry. Work is at present proceeding on a second prototype.

In summing up, Air Commodore A. V. Harvey, deputy chairman of Handley Page, Limited, said that the Herald had been produced entirely without Government assistance. It had been designed to satisfy many different demands and was intended as a "D.C.3 replacement."

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INSTITUTE OF MATERIALS HANDLING

Annual Meeting and Dinner

Formed in 1952 to provide a common meeting ground for the discussion of handling problems and to review the techniques of the conveyance, packing and dispatch of all types of products and goods, the Institute of Materials Handling, 20-21 Took's-court, Cursitor-street, London, E.C.4, held its third annual general meeting at the Trocadero Restaurant, Piccadilly-circus, London, W.1, on June 28. At this meeting, Mr. Alexander Lyle, of Tate and Lyle, Limited, was elected the national chairman, in succession to Mr. John Bright who now becomes an *ex-officio* member of the Council of Management.

Proposing the toast of the Institute at the annual dinner which followed the annual general meeting, Sir Graham Hayman, President of the Federation of British Industries, congratulated the Institute on its steady growth, the membership now standing at 900, distributed in five divisions which covered the whole country. In the past, added Sir Graham, the handling of materials had been taken too lightly. As a subject it was not so interesting as the design of new plant; nevertheless, it had a direct bearing on productivity and on the export trade. The cost of materials handling, in fact, was responsible for an appreciable portion of production costs in many industries.

In his reply to the toast, the chairman, Mr. Alexander Lyle, said that many of the problems connected with the handling of materials appeared simple and were of common occurrence but, often, a solution had still to be found. The aim of the Institute was to provide facilities whereby the accumulated knowledge in the industry could be disseminated to the advantage of all its members.

The toast of the guests was proposed by Mr. C. Y. Hardie and acknowledged by Mr. R. T. Gardner who referred to the growing importance of the fork-lift truck and its essential part in the handling of materials in the modern factory.

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NEW SHOWROOMS AND NEW TYPEWRITER

A typewriter claimed to be the first post-war typewriter of exclusively British conception and design was one of the exhibits at the opening of new showrooms by Byron Business Machines, Arnold-road, Nottingham. The new showrooms are at Ingersoll House, Kingsway, London, W.C.2, and they were opened by Lady Barnett, wife of the company's deputy chairman. The typewriter has only some 2,000 parts, compared with the normal 2,400 of most machines.

BOOK REVIEWS

Higher Transcendental Functions. Volume III. Based, in part, on notes left by Harry Bateman. Compiled by the Staff of the Bateman Manuscript Project. Edited by A. ERDÉLYI. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (6.50 *dolls.*); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.*4. (49*s.*)

The present volume completes the important work on the Higher Transcendental Functions based partly on material assembled by the late Professor Harry Bateman with additions contributed by a distinguished team of Mathematicians under the direction of Professor A. Erdélyi. The responsibility for its publication was assumed by the California Institute of Technology with financial support from the U.S. Office of Naval Research. Though this volume was prepared after the staff of the Bateman Manuscript Project had left Pasadena the same general plan has been followed as was adopted in the first two volumes. Separate chapters are devoted to specific functions and, in them, the properties of the various functions, their interrelations, their representation in alternative forms and their behaviour are comprehensively investigated, while the resulting formulae are tabulated in such a way as to be directly useful to workers in the fields of pure and applied mathematics.

A commendable feature is that explicit mention is made, usually at the beginning of a chapter, of any topics that are merely outlined or that have had to be omitted altogether, either as lying outside the scope of the work or because adequate treatments are available elsewhere. At the same time a number of gaps in our knowledge, which might with advantage be filled by future work, are pointed out. Another useful feature is the care taken to indicate particular notations used by different authors who have studied the various functions, where these differ from those now generally adopted. In the references at the end of each chapter attention is mainly confined to the more recent papers, and, for the earlier papers, attention is directed to standard treatises in which lists of these may be found.

The opening chapter on automorphic functions contains a number of basic definitions and some easily accessible examples of such functions, in particular, elliptic modular functions. Following this is a discussion of Lamé functions, which arise in solutions of Laplace's equations in certain systems of curvilinear coordinates, and in which the main stress is on the more recent theories of periodic Lamé functions and Lamé-Wangerin functions. The treatment of Mathieu functions follows McLachlan's standard book on the subject while the sections on spheroidal and ellipsoidal wave functions are based largely on Meixner's papers and Strutt's monograph. Though, in the next chapter on functions of number theory, no comprehensive survey has been attempted (the theory of algebraic numbers, for example, has been excluded) the more important properties of certain arithmetical functions, such as Riemann's zeta function and Ramanujan's function, are given. There are also sections on partitions, congruence properties and lattice points, and Professor Apostol has contributed a section on Bessel function identities. Under miscellaneous functions some of the less familiar special functions, such as Mittag-Leffler's function $E_\alpha(z)$, trigonometric and hyperbolic functions of order n, the functions $\nu(x)$ and related functions first encountered by Volterra, are considered. The final chapter contains a general survey together with an extensive list of generating functions. The bulk of the material for this was compiled by Professor Bateman himself and a supplementary list has been contributed by Professor E. D. Rainville. At the end of the volume there is a subject index and an index of notations which does not repeat the more familiar notations introduced in the earlier volumes and listed in them.

Though it has not proved possible to include some of the chapters, containing lists of differential equations, power series, etc., as originally envisaged by Professor Bateman, and although two of the chapters in the present volume are stated by the Editor to be "frankly experimental," no other tables of the Higher Transcendental Functions of a similar scope or on a similar scale exist. The three volumes, now completed, provide a unique source of reference to which all workers in advanced mathematics will turn for information and guidance. They also serve as a worthy and enduring memorial to the versatile mathematician whose long and fruitful labours were responsible for their inception.

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BRITISH STANDARDS

The following publications have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 2 Park-street, London, W.1, at the price given after each title.

Metal-Arc Welding of Weldable Structural Steel Tubes. (4*s.*, post free.)

A revision of B.S. 938, covering the general requirements for the metal-arc welding of weldable structural steel tubes has been issued. It is a companion standard to B.S. 1856 which contains the general requirements for the metal-arc welding of mild steel, and, like that standard, is not applicable to certain forms of construction nor does the standard specify the allowable stresses in welds or methods for their testing. B.S. 1856 based its requirements for weldability in terms of chemical composition, whereas the present B.S. 938 : 1955 is based entirely on mechanical properties, the chemical composition being unrestricted. The steel tubes involved comply with B.S. 1775, which concerns steel tubes for mechanical, structural and general engineering purposes.

Sizes and Outputs of Crushing Machinery. (2*s.* 6*d.*, post free.)

Descriptions and methods of measuring the sizes and outputs of crushing machinery when used for producing aggregates for constructional work are given in a new standard, B.S. 2595. The publication defines the various types of machines in common use and includes methods of measuring their capacities and sizes. For the purpose of the standard, hard limestone has been selected as the test material. In the case of rolls, impact breakers and hammer mills, it was felt that owing to the large number of variables it was impossible to define a standard method of measuring output and, therefore, sizes only are specified for these machines.

Glossary for Valves and Valve Parts (for fluids; Part 1. Screw-down stop, check and gate valves.) (10*s.* 6*d.*, post free.)

In the course of the preparation of British Standards for valves of various types and for various purposes, it has become apparent that there is a need for consistency in the terminology used to describe individual valves and their parts. This need has been met by the issue of the above *Glossary* which is designated B.S. 2591: Part 1. It defines types of, and parts for, the following types of valves. (*a*) Screw-down stop valves: globe, oblique, angle and needle valves. (*b*) Check valves: horizontal, vertical and angle patterns of the swing and lift types and screw-down stop and check valves and foot valves. (*c*) Gate valves, both inside screw and outside screw, of the wedge-gate valve, sluice-valve, double-disc gate valve and paralled slide-valve types.

The standard does not apply to draw-off taps or stop taps or their parts, but for purposes of clarification, the term "tap" is defined as any draw-off tap having a free outlet, such as bib tap, hose tap, pillar tap and globe tap, and any screw-down or stop tap of similar design for insertion in a pipe line. These taps and their parts are fully defined in B.S. 1010.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Bailey Bridging. THOS. STOREY (ENGINEERS) LTD., 6 Victoria-street, London, S.W.1. Bailey bridge equipment for railway and road bridges and details of company's hire service. Descriptions of deck-type bridge at Tolka River (emergency railway bridge); Cwmbran "double-single" access road bridge; and a "double-double" with reinforced chords at Prestolee. Three illustrated leaflets, Bailey bulletins Nos. 5, 6 and 7, respectively.

Building Maintenance. MAXWELL ADVISORY SERVICE BUREAU (The Liverpool Borax Co. Ltd.), St. Pauls-square, Liverpool, 3. Preservation and protection of all types of structures, including metal and felt roofs; emphasis on efficient preparation before any maintenance work is undertaken. Revised leaflets entitled "Building Maintenance—Roofs, Rust Prevention and Waterproofing" and "Paint Cleaning the Easy Way."

Prefabricated Buildings. METAL SECTIONS LIMITED, Oldbury, Birmingham. Prefabricated three-pin arches of cold-rolled formed sections using "Cor-Ten" (low-alloy) steel, together with purlins, stringers and bracing, etc. for quickly erected sheds. Cladding of asbestos sheet or similar. See ENGINEERING of May 27, page 680, vol. 179 (1955). Illustrated catalogue.

Small Aeration Plants. AMES CROSTA MILLS AND CO., LTD., Moss Iron Works, Heywood, Lancashire. Small sewage-treatment plants suitable for single village, school, army camp, etc. Specifications and illustrated descriptions of plant. Leaflet No. 54.

Conveyor-Belt Structures. MINING MACHINERY, LTD., Custom House Chambers, Newcastle-upon-Tyne, 1. "Catto" tubular supports for belt conveyors; easily assembled tubular frame with telescopic legs. Adjustable roller idlers which ensure good belt tracking. Illustrated leaflet.

Commercial Lighting Fittings. HOLOPHANE LTD., Elverton-street, London, S.W.1. Lighting fittings for premises, window displays, and interior flood-lighting. 40-page catalogue lists types available and gives curves for calculating the utilisation factor.

Centrifugal Blowers and Exhausters. WHITTAKER, HALL & CO (1929) LTD., Black-lane Works, Radcliffe, Manchester. Multi-stage centrifugal blowers and exhausters, capacities up to 1,000 cub. ft. per minute. Leaflet gives performance curves for each size.

Quartz-Crystal Units. SALFORD ELECTRICAL INSTRUMENTS LTD., Silk-street, Salford 3, Lancashire. Quartz-crystal units for all purposes within the frequency range 0·4 kc/s up to 55,000 kc/s. Also filter types, sockets and plates. List No. QC5503.

Selenium Rectifiers. SALFORD ELECTRICAL INSTRUMENTS LTD., Silk-street, Salford 3, Lancashire. Selenium metal rectifiers for radio and television. Sizes available and regulation curves for various connections. List No. S.R.(R.T.) 5504.

Oil and Grease. ALEXANDER DUCKHAM & CO. LTD., Hammersmith, London, W.6. Booklet, "A Guide to Industrial Lubrication" lists over 300 grades of oils and greases for cutting, quenching, lubricating, hydraulic systems, and hand cleaning.

Friction Clutches. WHITTAKER, HALL & CO. (1929) LTD., Black-lane Works, Radcliffe, Manchester. Multi-plate spring, pneumatic and centrifugal clutches for power drives and take-offs. Capacities up to 400 h.p. at 100 r.p.m. Illustrated pamphlet.

Mill Rolls. ARMSTRONG WHITWORTH (METAL INDUSTRIES) LTD., Close Works, Gateshead-upon-Tyne, 8. Iron and steel rolls for rolling ferrous and non-ferrous metals of all types and sections. Illustrated leaflet.

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PROBE ILLUMINATOR FOR CONTAINER INTERIORS

A probe illuminator, the object of which is to simplify the examination of the interior of drums and barrels, has been produced by Engineering Developments, Limited, 1 Adams-place, George-road, London, N.7. It consists of a tubular arm about 1 ft. 9 in. long (or longer if required) at the end of which is a cylindrical fitting, 1¾ in. in diameter. This fitting, which can be inserted through the filling aperture of the drum, contains an 18-watt lamp which is encased in a heat- and shock-proof glass shield and is protected by a wire cage. The lamp is supplied from the mains through a separate transformer and is controlled by a push-button switch in a finger-grip handle at the upper end of the arm. There is therefore no risk of the lamp being left in circuit for a long period and overheating is thus eliminated. The light emitted is sufficiently brilliant to illuminate fully the insides of the containers, even when they are coated with non-reflecting material.

International Internal-Combustion Engine Congress (*concluded from page* 784, *vol.* 179)

MARINE AND STATIONARY ENGINES

OUTPUTS OF 10,000 H.P. AND OVER

The nine papers in Group "C," Marine and Stationary Engines, were spread over three sessions, in the afternoon of May 25 and the morning and afternoon of May 26, the chairmen being, respectively, Professor E. Sörensen, director of the Maschinenfabrik Augsburg-Nürnberg, Dr. R. de Pieri, principal director of the F.I.A.T. organisation, and Mr. H. Andresen, of Burmeister and Wain, Limited.

TURBO-CHARGED TWO-STROKE ENGINE

The first paper in this group, by Mr. Søren Hansen, the chief designer of Burmeister and Wain, Limited, described that firm's latest type of two-stroke engine with turbo-charging, for powers in excess of 10,000 brake horse-power per shaft. Most of the engines in service run on boiler oil as fuel and it was stated that they were proving satisfactory, there being no apparent increase in cylinder wear. So far as could be judged, the maintenance costs were less than with engines without turbo-charging. Although the mean effective pressure was higher, the temperatures in the cylinders were no greater, because of the adequate air supply and the fact that the charging air passed through an inter-cooler. As a result of turbo-charging, it was possible to offer to shipowners engines of 15,000 to 17,500 brake horse-power on a single shaft. The turbo-chargers used were of the Rateau type; two were fitted on eight-cylinder engines and three on nine-cylinder engines. The normal blast of starting air was sufficient to give the chargers an initial speed which enabled them to run quickly up to operating speed as the load was put on the engine. Particulars were given in an appendix of a number of ships equipped with two-stroke supercharged engines of the type described, with six, seven, eight and nine cylinders.

As often happens when a "proprietary" paper is delivered, the discussion was largely sustained by representatives of other firms. Some particulars were given of an experimental ten-cylinder Götaverken engine which, it was stated, would give 12,500 h.p. with two turbo-chargers, but which could be run without super-charge; but it was not clear whether this was the same engine as was referred to by another speaker, who stated that an increased output of 35 per cent. had been obtained by supercharging. The fuel analysis given in the paper, another contributor remarked, showed such a very high ash content, as well as high sulphur and high asphalte, as to suggest that it might have become contaminated *en route* to the ship; he inquired whether the fuel used in the engines was used as bunkered or whether it was centrifuged. Comment was made on the author's reference to choking of air coolers and he was asked whether it could be overcome by fitting filters or cleaning doors; did he think that both were necessary or, if only one, which would he prefer? There was some criticism of the statement that the supercharging did not increase the maximum pressure in the cylinders, the opinion being expressed that Lloyd's Register would still insist on a crankshsft of greater diameter; and of the claim that the starting air would run the turbo-blower up to a workable speed. The author, in reply, said that effective filters were the best means of ensuring clean coolers, but he liked to have cleaning doors as well. The crank-shafts were designed initially for a higher power, and the pumps were the same, whether the engine was to be turbo-charged or not. Manoeuvring was quick and responsive, provided that the turbo-charger did not come to rest between engine movements.

DUTCH DEVELOPMENTS

Mr. F. G. van Asperen, chief engineer of the marine Diesel engine department of Werkspoor N.V., Amsterdam, presented a paper on "The Development and Service Results of a High-Powered Turbo-Charged Two-Stroke Marine Diesel Engine." He stated that the highest power reached with the design described was about 10,000 h.p., the engine having 12 cylinders, 680-mm. bore and 1,250-mm. stroke, and running at 125 r.p.m. Two Brown-Boveri turbo-chargers were fitted, and the overall fuel consumption averaged 34·5 tons per 24 hours, including about 1½ tons for the auxiliaries. It was considered that the maximum power possible with the design was about 16,000, but this would involve greater cylinder dimensions, as it was not practicable to increase the number of cylinders. A section of the paper was devoted to the consideration of the steam production of exhaust-gas boilers and their influence on the total fuel consumption; and another section, to an analysis of the replacement costs attributable to wear of chromium-plated and special cast-iron cylinder liners.

Ir. G. Wieberdink and Ir. A. Hootsen, of the Stork Engineering Works, Holland, described the application of supercharging by turbo-blowers to two-stroke marine Diesel engines of more than 10,000 brake horse-power, with particular reference to the design of engine developed by their firm. This engine, which has uniflow scavenging by means of inlet ports in the cylinder liners and four exhaust valves in the cylinder cover, can deliver 1,250 brake horse-power per cylinder of 750-mm. bore. It is fitted with one turbo-blower for each pair of cylinders, of the Brown-Boveri V.T.R.500 type, driven by exhaust-gas turbines. These turbines together develop a power equal to about 10 per cent. of the main-engine output. The full-load speed of the turbines is about 8,500 r.p.m. and, as they are fitted with ball bearings, they will continue to run for 10 to 15 minutes before coming to rest, which facilitates manoeuvring; but it was stated that, when they were at rest, the energy from the starting air admitted to the main engine was sufficient to bring the turbines up to a speed of 2,000 r.p.m. Air-intake silencers were fitted to the blowers and had proved very efficient.

JAPANESE RESEARCH

The remaining paper presented at the afternoon session on May 25 was by Mr. Hideo Fujita, assistant manager in the design department of the Mitsubishi Shipbuilding and Engineering Company, Nagasaki, who described the "UEC" type of single-acting two-stroke engine developed by that company. The engine has uniflow scavenging and is supercharged by turbo-blowers, driven by exhaust-gas turbines. Extensive experimental work had been undertaken, the author stated, with a three-cylinder engine with cylinders 720 mm. bore and 1,500 mm. stroke, and on the basis of the experience gained with it the company had put in hand two nine-cylinder and two six-cylinder engines, which were still under construction. Their rated outputs were 12,000 brake horse-power, and 8,000 brake horse-power, respectively, at 120 r.p.m., of 1,333 brake horse-power per cylinder; a comparatively conservative rating, as the experimental engine had been run at nearly 1,500 brake horse-power per cylinder. Research work was continuing with a view to using a higher supercharge.

OPPOSED-PISTON ENGINE

At the morning session on May 26, four papers were discussed. The first of these, by Mr. P. Jackson, M.Sc., of William Doxford and Sons, Sunderland, dealt with "The Development of the Opposed-piston Engine to 10,000 h.p. and Over." The author stated that the highest-powered engine of that type now being built was of 9,000 shaft horse-power continuous rating, with six cylinders of 750 mm. bore and 2,500 mm. combined stroke; the m.e.p. was 90 lb. per square inch and the average piston speed was 900 ft. per minute. Research and development work on experimental engines had shown that the mean indicated pressure could be raised to 105 lb. per square inch and the piston speed to 1,000 ft. per minute, corresponding to an output of over 11,000 shaft horse-power. By supercharging with Brown-Boveri exhaust turbo-blowers, the power could be increased to 15,000 with six cylinders. The experimental three-cylinder engine thus fitted was provided also with an engine-driven scavenging pump, so that the engine could continue to operate even if the turbo-blower should break down. It had been run for more than two years on boiler fuel and had shown a mechanical efficiency of nearly 92 per cent. Mr. Jackson strongly advocated the use of after-coolers to reduce the temperature of the air delivered by the blowers to the engine; he doubted whether more than 15 per cent. increase in power could be obtained by super-charging without the use of an after-cooler, whereas, with an after-cooler, a 30 per cent. increase was easily obtained and 50 per cent. should be practicable "within the next few years."

The prospects of building marine engines of more than 10,000 brake horse-power were discussed in general terms by Mr. M. Zwicky, of Sulzer Brothers S.A., Winterthur, Switzerland. A few such engines had been built and had proved satisfactory, but shipowners did not seem desirous of adding to the number. He considered, however, that it would be to their interest to give more attention to the subject of higher outputs per shaft. An engine was under construction at Winterthur, for a single-screw tanker, which was designed to develop 15,000 h.p. at 115 r.p.m. It was of the two-stroke type, supercharged.

FREE-PISTON GENERATOR

Mr. R. Huber, technical director of the Société d'Etudes Mécaniques et Energétiques, presented a paper on "Marine and Stationary Applications of the Free-piston Generator with Gas Turbine of more than 10,000 h.p." Many such plants had been put into service during the past two years, he said, though they were mainly of small size; a marine set of 6,000 h.p., however, was under construction. He outlined a scheme for a power station of 7,500 kW capacity (10,000 h.p.) to contain ten free-piston generators supplying one turbo-alternator, and suggested that that output was by no means the maximum practicable, on the basis of previous experience. With a marine installation, certain problems would arise in reversing and in running astern; a considerable part of the paper was devoted to consideration of the conditions governing those manoeuvres, in the case of a tanker of 31,000 tons, making 15 knots.

The fourth paper presented at the morning session on May 26 was by Dr. Fr. Schmidt, of the M.A.N. Company, Augsburg, and compared the claims of the direct-drive Diesel engine and the geared engine for high outputs. The geared installation which he advocated would consist of high-speed engines, coupled by gearing into units of as much as 25,000 h.p. It was claimed that the overall weight would be considerably less than that of a direct-drive set of equal power; but it was admitted that the geared plant would be noisier and that the fuel consumption might be somewhat higher. The comparison was extended to include steam turbines and also Diesel-electric machinery.

FOUR DIESELS ON ONE SHAFT

Two papers only remained to be considered at the final technical session, on the afternoon of May 26, these being the contributions of Mr. H. Sinobad and Mr. P. Rouet, respectively chief engineer and engineer of the Ateliers et Chantiers de Bretagne, at Nantes, giving a "Comparative

Analysis of Single-screw Diesel and Steam-turbine Propelling Plants developing 10,000 s.h.p. and over"; and of Dr. Ing. A. Fontana, of the Cantieri Riuniti dell' Adriatico, Trieste, and Ing. S. Filippini, of the Fiat Company, Turin, who surveyed "25 Years of Actual Operation at Sea of Two Large Passenger Motorships."

Mr. Sinobad and Mr. Rouet, premising that the large tanker had brought into a new prominence the development of single-screw machinery of more than 10,000 h.p., hitherto the preserve of the steam turbine, proposed to use four Diesel engines of 2,500 h.p. or more, of the semi-high-speed type, geared to a single shaft. They considered that it was practicable to use engines running at 200 to 500 r.p.m. which would be as reliable as those of 100 r.p.m., and to do so at a first cost only 10 to 15 per cent. more than that of a steam-turbine plant of equal power. The weight of the Diesel plant would be 20 to 25 per cent. greater than that of the steam plant.

The ships which were the subject of the paper by Dr. Ing. Fontana and Ing. Filippini were the Saturnia and Vulcania, the first motorships to have engines of more than 10,000 h.p. When they were built in 1926-27, these ships were fitted with twin-screw air-injection Burmeister and Wain engines, but they were re-engined in 1935-36, the Saturnia with Sulzer ten-cylinder double-acting solid-injection engines of 13,000-14,000 h.p. each, and the Vulcania with ten-cylinder Fiat engines, also of the double-acting two-stroke type, developing rather more than 18,000 h.p. each. The paper was divided into two parts, dealing, respectively, with the two types of engine and their performance in service, and going into considerable detail regarding the results obtained, and the nature and extent of the maintenance and replacement of working parts. It was noted that, in the case of the Vulcania, a certain amount of trouble was experienced with the alignment of the crankshafts, partly due to insufficient rigidity of the bedplates. Otherwise, the machinery had functioned satisfactorily. Only 14 of the 20 cylinder liners had needed replacement, and then only after 10 to 12 years of service.

British Electrical Power Convention (*Continued from page* 7)

ELECTRICAL GENERATION IN THE NEXT TEN YEARS

At the meeting which was held in The Dome on Wednesday morning, June 29, a paper "The Generation of Electricity in Britain—British Electricity Authority (Ten-Year Forecast)" was presented for discussion by Mr. J. Eccles. After a brief historical survey showing the development of electricity supply in Great Britain since 1920, the author described the methods adopted by the Central Electricity Authority and the Area Boards to estimate load growth and required plant capacity. The essential feature of these predictions was that they were based on rates of growth. The risks of error were therefore subject to inevitable increases in scale as the time covered by the estimate grew longer. For this reason it was important in the pursuit of maximum economy that the critical forecast period should be kept as short as possible. The system had now been functioning sufficiently long for experience to have begun to accumulate and an estimate showed that the installed capacity of the generating plant required in the winter of 1964-65 would be 36,000 MW, compared with 20,173 MW on March 31, 1955.

CONVENTIONAL GENERATING PLANT

In preparing a generating plant programme it was necessary not only to know the amount required, but the location of the load and the source, kind and amount of the fuel supply. The Ministry of Fuel and Power estimated that there would be a progressively widening gap between available home-produced coal and that needed for electrical generation. As both imported coal and oil were likely to be costly and their supply uncertain, attention was being given to the development of nuclear fuel as a more reliable and economical alternative.

Estimates showed that the capital cost per kilowatt of the early nuclear power stations would be relatively high and the running cost relatively low. The average cost per kilowatt-hour produced would therefore be a minimum if these stations supplied the base load. This raised questions as to the most economical size and type of conventional generating unit to supply the remainder of the load. It would seem that the bulk of the future conventional plant would have to be capable of single and two-shift working and this might place an upper limit on the size of the sets and on the steam temperatures and pressures used.

Perhaps the right answer to these questions would be for manufacturers to make all sets suitable for frequent starting and stopping. This might also be important from another aspect. For, if in future the cost per kilowatt of nuclear stations approached that of conventional stations, the latter would only be able to hold their own as economical producers, even at low-load factors, provided their thermal efficiency was a maximum.

Summarising the considerations which had determined the size and type of conventional generating plant installed, and to be installed, the speaker said that since 1948 the bulk had consisted of either 30-MW or 60-MW sets, operating at 600 lb. per square inch and 850 deg. F., and 900 lb. per square inch and 900 deg. F., respectively. The 60-MW set was the first true post-war development and some 118 had now been installed or ordered. Boiler availability had been improved to a point where the installation of spare capacity could no longer be economically justified, thus leading to the conception of the unit system. Design had been simplified and mechanical reliability improved by the widespread use of welding. The elimination of steam-driven feed pumps and auxiliary oil pumps was another method of improving availability and this trend had been carried even further on plant operating under higher steam conditions.

The economic necessity to conserve fuel had led to the ordering of eight 60-MW and ten 100-MW sets to operate at 1,500 lb. per square inch and 1,050 deg. F.; and the adoption of the unit principle had brought about a reconsideration of reheating as a means of improving the efficiency of generation. The first large reheating unit plant would have a capacity of 100 MW, with steam conditions of 1,500 lb. per square inch and a 975 deg. F. and a reheat temperature of 950 deg. F. Four reheat units of this size were on order. Since reheating reduced the amount of steam consumed per unit generated, it was possible to use the blades developed for the 100-MW non-reheat cycle to produce a greater output. Accordingly, it had been decided to introduce the 120-MW unit with initial steam conditions of 1,500 lb. per square inch and 1,000 deg. F. with reheating to 1,000 deg. F., the associated boiler rating being 860,000 lb. per hour. Eight of these units had been ordered and were replacing the standard 60-MW sets in the current programmes.

DESIGN OF 120-MW UNITS

The design of the 120-MW units exhibited no fundamental change from that for 60-MW, but certain trends were observable. The furnace volume tended to become uneconomically large for the required cooling surface, the cooling effect of the water walls was felt less and less towards the centre of the furnace and consequently high gas temperatures were produced at this point. This difficulty could be overcome by a wall of water-cooled tubes extending either partially or completely across the centre of the furnace. Corner firing, however, made this impracticable. With higher steam conditions, and the use of reheating, it became more difficult to accommodate the whole of the superheating surface in the convection zone of the boiler. There was, therefore, a trend towards the use of some radiant surface for the superheaters and reheaters, thus flattening the boiler temperature characteristic and reducing the rate at which the steam temperature decreased with the load.

TRENDS IN TURBINE DESIGN

The main trends in turbine design were towards the use of double casings for the high-pressure cylinders and solid, instead of flexible, couplings between the rotors. Steam-driven auxiliaries and steam-operated air ejectors had been discontinued. The generators were hydrogen-cooled, a pressure of 30 lb. per square inch being specified for the 120-MW units, thus enabling the size to be reduced and causing the saving in capital cost to outweigh a small reduction in efficiency. Designs, which were now being developed, should provide sufficient flexibility of control to ensure the proper relationship between the temperatures of the boiler steam and the casing metal. This was an important factor in the rapid starting of a turbine after an overnight shut-down. The thermal stressing of steam chests and piping was still a problem. Austenitic steels enabled metal thickness to be reduced, but, owing to the higher coefficients of expansion, and lower thermal conductivities, did not necessarily lead to lower thermal stresses.

THE NEXT STEP

As soon as the 120-MW reheat programme was under way the Authority had turned their attention to the next step in size and steam conditions, in order to secure further economies. Bearing in mind the value of standard components in keeping down development costs, the limitation on the safe speed of the electrical rotor and the problems of evaporation as the critical pressure of 3,200 lb. per square inch was approached, a 200-MW unit with steam conditions of 2,350 lb. per square inch and 1,050 deg. F. at the turbine stop valve and a reheat temperature of 1,000 deg. F. was selected. The boiler for an installation of this kind, which would be installed at High Marnham, would have an output of 1,400,000 lb. per hour. It would be of the twin-furnace design with assisted circulation

The alternator stator was to be kept within road transport limits by employing direct hydrogen cooling of the conductors and the same system was to be used on the rotor to provide safe operation at 3,000 r.p.m. With direct cooling it was possible to obtain a much greater rating from a given alternator frame size and consequently the cost per megawatt should be less. Against this, however, must be placed the cost of the additional losses due to the higher current density in the conductors.

SUPER-CRITICAL RANGE

A still further step would be into the super-critical range with a steam pressure in the region of 4,000 to 5,000 lb. per square inch. A study of all the relevant factors to obtain the best results showed that increased rating normally produced a reduction in cost per kilowatt, while increased steam pressure and temperature tended to make the plant more expensive. Furthermore, higher steam conditions gave a higher thermal efficiency, but the value of this gain depended upon the capital cost of achieving it, the price of fuel and the load factor at which the plant was to operate. Special cooling arrangements, although necessary for safety in very large machines, reduced the efficiency of the alternator. It was believed that

the fuel cost per unit in nuclear power stations would be less than that of the most advanced stations burning coal or oil. The problem, therefore, resolved itself into how much nuclear fuel would be available, what would be the capital cost of the new stations and what was the right balance between capital cost and thermal efficiency to produce the most economical results at their prevailing load factors.

PUMPED STORAGE

In a concluding section of the paper, reference was made to a pumped storage scheme which the Central Electricity Authority was seeking to construct at Blaenau Ffestiniog in North Wales. This would make use of two reservoirs, less than a mile apart, with a difference in head of about 1,000 ft. The proposed plant capacity was 300 MW and the annual output about 300 million kilowatt-hours. The main advantages of the scheme were a saving in capital cost, compared with an equivalent thermal generating station and an even greater saving in the annual costs of production. It would provide readily-available stand-by capacity, thus relieving steam plant from this duty with a consequent saving in fuel costs. It would be more flexible in operation than steam plant, it being estimated that the sets could be brought on to full load from standstill in about five minutes. Pumped storage was an effective means of providing peak-load power on a system which was mainly supplied by steam plant of varying ages and efficiencies. On a system supplied by nuclear power stations it might be even more attractive.

A resumé of the discussion on Mr. Eccles's paper and an account of the later proceedings of the Convention will appear in subsequent issues.

FLEXIBLE WIRE ROPES FOR PULLEY SYSTEMS

A COMPARISON OF CONVENTIONAL AND SPECIAL LAYS

By John F. Sutton, M.SC.(ENG.), M.I.MECH.E.

The subject of the following article, which deals with wire ropes for pulley systems, is a comparison, mainly in terms of flexibility and fatigue strength under repeated bending cycles, of ropes of conventional lay and ropes in which the strand wires are twisted in the same direction as the strands in the rope ("Lang's lay"). In addition, certain ropes tested embodied "equal lay" construction, in which all the wires in a strand have the same length of lay or helical pitch, so that the outer wires bed down in the spaces between the inner wires. It is shown by a graphical comparison of test results that the special lays have a distinct advantage in length of life under moderate loading over ropes of ordinary lay; finally the inadequacy of present safety-factor requirements for running ropes is underlined. Table I gives details of ropes investigated, strands of which are shown in section in Figs. 1, 3 and 4.

There are many possible arrangements in which steel wires can be laid up into strands to make flexible rope. A type of rope which has been in general use for many years for hoisting, is known as 6/37 "ordinary" or "regular" lay. It has six strands each of 37 wires, laid up on a fibre core, with the direction of twist in the wires opposite to that of the made-up strands. This type of rope is simple to construct and easy to handle. When very lightly loaded over large-diameter pulleys it gives a reasonable length of life. The reason for using 37 wires in a strand will be seen from Fig. 1.

WIRE AND PULLEY INDENTATION

The first lay of six wires can be conveniently carried on a king wire of slightly larger diameter. It is then possible to put on the second and third lays of 12 and 18 wires respectively, all of the same diameter. In order that the finished strand shall be circular in section, it is necessary to prevent the outer wires from slipping into the grooves between the inner wires, and this is achieved by varying the helical pitch or length of lay of successive lays. When the strands are made up into a rope they bed on the fibre core, but if, later, the rope is heavily loaded and bent round a pulley the strands bear on each other also. It will be noticed on inspection of a rope of this kind that, where adjacent strands touch each other, the outer wires of the strands are crossing at the point of contact at about 45 deg. The effect of this, and of the crossing of wires in successive lays is to cause local wear and indenting of wires after a period of use, as can be seen in Fig. 2, with consequent loss of strength.

A further undesirable feature of rope made in ordinary or regular lay is that the outer surfaces of the wires where they bear on a pulley face have a very small area of contact with the face, with the result that the bearing pressure is extremely high. It may, in fact, be high enough when a rope is heavily loaded to cause indentation of the face of a mild-steel pulley, that is, it is likely to be over 20 tons per square inch.

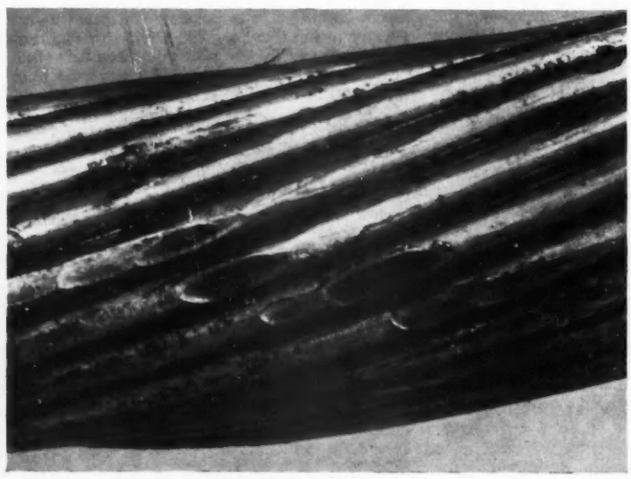

Fig. 2 The strands of ordinary-lay ropes are twisted in the opposite sense to their constituent wires; thus the outer wires of different strands cross each other at about 45 deg., and after a period of use local indenting occurs.

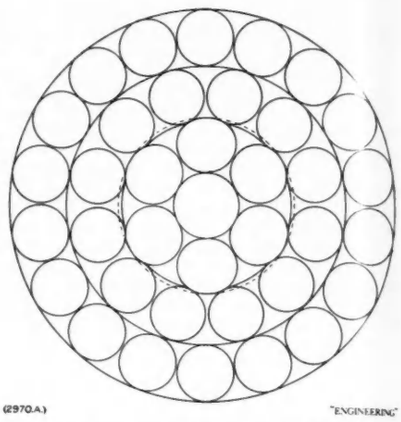

Fig. 1 Section of strand of 6/37 ordinary-lay wire rope. The helical pitch of successive lays is varied to prevent outer wires slipping into the grooves between inner wires. The resulting concentrated bearing causes local wear.

LANG'S LAY AND EQUAL LAY

It has been possible to minimise all these disadvantages by the improvements in design known as "Lang's lay," "equal lay" and "preforming." In Lang's-lay construction, the wires in a strand are twisted in the same direction as the strands in the rope. The resulting improvement is twofold: the outer wires in the rope are found to bear for a longer distance on the face of a pulley, thus reducing the contact pressure; and at the point of contact between strands the wires are nearly parallel, instead of crossing at a large angle. The disadvantage of Lang's lay is the increased difficulty of handling the rope, since both the rope and the strands tend to untwist in the same direction. This disadvantage is to a large extent overcome by preforming the wires and strands so that the initial spring is taken out of the wires when laying up.

The term "equal lay" is used to indicate that the length of lay, or helical pitch, of all wires in a strand is the same; that is all the outer wires bed down in the spaces left between inner wires, with each strand arranged geometrically, so that this is possible while retaining a circular outer strand form. Fig. 3 shows a construction of an equal-lay strand with 36 wires, made up of 7 in the first lay on a king wire, then a mixed lay of alternate large and small wires, and an outer lay of 14 wires of equal diameter. This construction involves four different sizes of wire per strand, and in addition, it is necessary to lay up the strand of 36 wires in one operation since the helical pitch of each lay must be exactly the same. Fig. 4 shows a similar method of

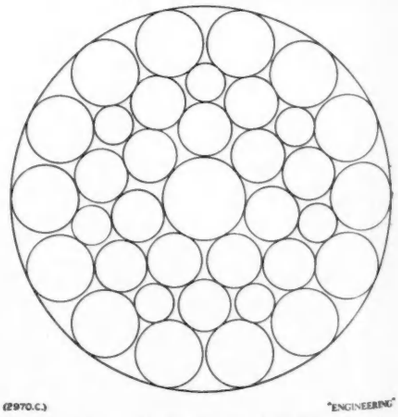

Fig. 3 Rope design may be improved by: Lang's lay, in which wires and strands are twisted in the same sense; preforming, to prevent untwisting of Lang's lay; and equal lay (shown here) in which one lay beds in the grooves of another.

TABLE I.—Details of Ropes Investigated, Strands of Which are Shown in Figs. 1, 3 and 4

Nomenclature and Fig. No.	Rope circumference (in.)	Strands		Construction	King wire dia. (in.)	Fillers		1st lay			2nd lay			3rd lay		
		Number	Dia. (in.)			number	dia. (in.)	number of wires	Length of lay (in.)	Dia. of wires (in.)	Number of wires	Length of lay (in.)	Dia. of wires (in.)	Number of wires	Length of lay (in.)	Dia. of wires (in.)
6/37 (Fig. 1)	3½	6	0·34	Ordinary lay	0·057			6	1½	0·048	12	2¾	0·048	18	3¾	0·048
6/36 (Fig. 3)	3½	6		Equal lay	0·070			7		0·045	7		0·045	14		0·055
											7		0·035			
6/19 (Fig. 4)	3½	6		Equal lay with filler wires	0·074	6	0·029	6		0·068	12		0·064			

attaining the same result with lays of 6 and 12 wires instead of 7 and 14. This produces a strand known as 6/19; the extra six small wires are called " fillers."

FATIGUE TESTS

Systematic fatigue trials at heavy loading have shown the advantage of Lang's-lay and equal-lay construction. One series of trials, limited to 3½-in. circumference rope, has consisted in running specimens of rope back and forth over pulleys of tread diameter 19·1 times the rope diameter while loading was maintained constant. Bending cycles were continued until the rope failed.

For the majority of the tests, failure was considered to occur at 6-wire breakages over a short length, but later trials were continued to complete failure. The graph in Fig. 5 shows some of the results plotted to give a comparison between the performance of the various constructions. Under very heavy loading, where the applied load was over 50 per cent. of the static breaking load, and where complete breakdown occurred after a few hundred stress cycles, there was not a very great difference between the performance of the various ropes. As the loading became more moderate the improved performance of Lang's-lay and equal-lay ropes became marked. The values applicable to 6/36 rope at a large number of stress cycles are not shown, but the part of the curve drawn on the graph is interpolated from them.

Table II shows the performance of the three types of rope at loadings of 10, 15 and 19 tons. The static breaking load of the specimens, adjusted to 115 tons per square inch steel, is about 40 tons.

Trials have also been made with 6/19 construction (Fig. 4). The performance of this rope is somewhat better than that of 6/36 on the same size pulleys in spite of the fact that the outer wire diameter, and therefore the stress due to bending, is greater. The values quoted in the table above are liable to vary by at least 5 per cent. with different batches of rope of the same construction, and the performance of ordinary-lay rope is likely to vary according to the amount of support given to the strands by the fibre core. To ensure reasonable life, it is probably advisable that the core should be sufficiently bulky to cause a slight gap to appear between the strands of newly made-up rope.

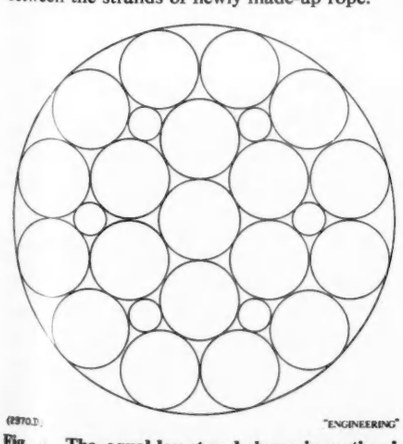

Fig. 4. The equal-lay strand shown in section in Fig. 3 is part of 6/36 rope; by use of filler wires a 6/19 equal-lay can be formed.

Table II.—*Stress Cycles Before 6-Wire Failure Occurred*

Loading, (tons)	6/37 ordinary lay. 115 tons per sq. in. steel	6/37 Lang's lay. 115 tons per sq. in. steel	6/36 Lang's lay. 130 tons per sq. in .steel	6/36 adjusted to 115 tons per sq. in. steel
10	6,450	No result	62,500	55,000
15	3,900	13,500	50,000	44,000
19	1,500	6,500	19,400	17,000

SAFETY FACTORS FOR RUNNING ROPE

The loading of the rope in these trials was heavier than that allowed by the Factory and Workshop Act, 1934, which states that the " safe working load shall not exceed one fifth of the breaking load of the sample tested." There is no indication that the relation between the performances of the different rope constructions will change appreciably at this lighter loading.

An effort has been made to determine the true safety factor of a rope run under steady loading conditions on a system of pulleys. If a rope is stationary and is bent over a pulley of reasonable diameter there is no appreciable loss in strength, that is, it will break at a value only slightly less than its normal static breaking load. However, a running rope will fail at a load not much more than 50 per cent. of its static breaking load, depending on pulley diameter, wire diameter,

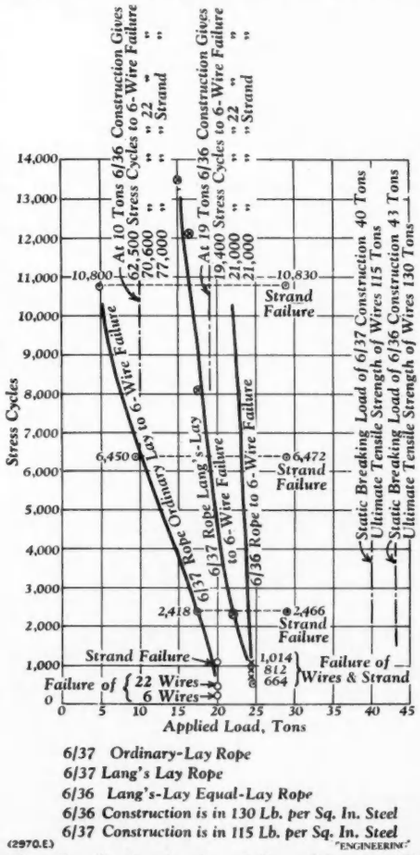

Fig. 5. Graph showing fatigue life of 6/37 ordinary-lay, 6/37 Lang's-lay, and 6/36 Lang's-lay equal-lay wire ropes in terms of applied load.

and other factors. Trials to measure factor of safety were made with 6/37 and 6/36 rope under running conditions and it was found that a sudden increase of load to 29 tons after the initial failure of 6 wires caused complete failure in both types of rope after about 30 stress cycles. The effect appeared to be independent of the initial loading unless the latter was very heavy, in which case complete failure followed immediately after 6-wire failure.

The conclusion drawn from this phase of the work is that the value of breaking load to be used in calculating safety factor is not the static breaking load but a value less than this according to the conditions of use. With a pulley ratio of 19·1 : 1 on the ropes tested it can be considered as 30 tons, or ¾ of the static breaking load, for other sizes of rope.

It is of course obvious from a study of the results presented here that further work could very usefully be performed to establish in more detail and precision the conclusions reached, but sufficient has been done to show (*a*) that a much longer life can be expected from the modern forms of rope construction compared with the original and still widely used 6/37 construction, and (*b*) that the true safety factor of a running rope is considerably less than the value of

$$\frac{\text{direct breaking load}}{\text{working load}}.$$

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AUSTRALIA'S SECOND LARGE REFINERY

With the completion in April last, of the oil refinery at Altona, near Melbourne, Australia has taken her second step towards becoming independent of imported petroleum. Costing £A20 million, and belonging to Standard-Vacuum Refining Company (Australia) Pty, Limited, the new refinery is the only one in the continent yet able to make high-octane fuels suitable for aircraft and is, in fact, able to supply more than half of Australia's requirements of aviation fuels, including three grades of jet fuel. The daily intake of the refinery is now 875,000 gallons of crude oil. Construction of the Altona refinery was by the Braun Transworld Corporation, a United States company, using Australian labour and, in large degree, local raw materials.

The first major Australian refinery, the Shell group's at Geelong, came into operation about a year ago. Two other refineries, both due to be commissioned by the end of 1956, are being built at Kwinana, Western Australia, and at Kurnell, New South Wales. These belong to the British Petroleum Company and Caltex Oil (Australia) Pty, Limited, respectively. Consumption of petrolium products in 1954 was 2½ times that in 1938, and a further increase of 30 per cent. is expected by 1958. Refining of the whole of the country's consumption would save £A27 million of imports and would simultaneously make Australia able to export finished petroleum products to her neighbours in the South Pacific and the Far East.

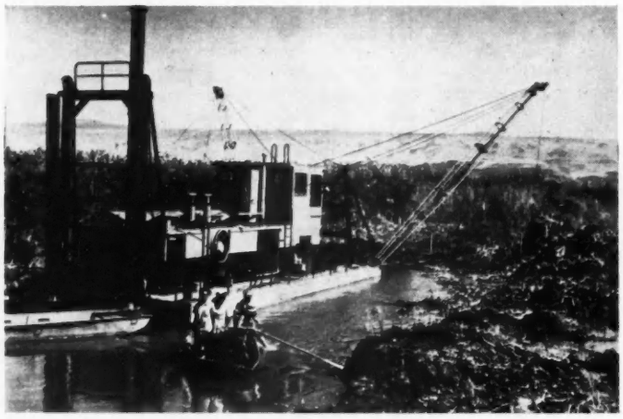

Fig. 1 The Huleh swamps are being drained to make the land fit for cultivation. Dredging of the main drainage channel is nearing completion.

Fig. 2 Construction of the experimental dam at Battauf, where a central reservoir with a capacity of 220,000 million gallons is to be constructed.

IRRIGATION AND POWER POTENTIAL OF THE JORDAN BASIN

By P. H. Doron, B.SC., A.M.I.C.E., M.A.S.C.E.

The possibilities of utilising the water of the Jordan River for irrigation and for power production have been receiving increasing attention in recent years, and some of the problems and possibilities are discussed below.

TOPOGRAPHY

The Jordan River is formed by the confluence, in the Huleh Valley in Northern Israel and as shown in the map, Fig. 4, of three tributaries: the highest, the Hasbani, which rises in the Lebanon at an elevation of 2,100 ft. above mean sea level (m.s.l.); the Banias which rises in Syria at an elevation of 1,150 ft. above m.s.l.; and the lowest, the Dan, which rises in Israel at 600 ft. above m.s.l.

Below the confluence the river flows in a generally southerly direction along the Jordan rift valley. It crosses the Huleh Lake and swamps at an elevation of 230 ft. above m.s.l. and then drops to Lake Tiberias (the Sea of Galilee) at a depth of 700 ft. below m.s.l. A little lower it receives its main tributary—the Yarmuk—and finally it discharges into the Dead Sea, the lowest area on the earth's surface, at a depth of 1,300 ft. below m.s.l. From there the water has no outlet and all inflow is balanced by evaporation from the surface of the Sea which averages about 80 in. per annum.

IRRIGABLE AREAS

The possibilities of utilising the Jordan water for irrigation are dictated by the orography of the area. The three northern tributaries rise in valleys sharply bounded by high mountain ranges, which continue in the form of a plateau 3,000 ft. high, flanking the Jordan Valley on the East for the whole of its length. On the West too, the northern part of the Jordan Valley is bounded by the high Galilee mountains; these drop gradually to only 200 ft. above m.s.l. where they are severed by the Valley of Esdraelon and then rise again towards the south as the Samaria and Judea Mountains.

Broadly speaking, irrigation possibilities are, therefore, restricted to the Jordan Valley itself (about 260,000 acres), to lands in certain of the tributary valleys (about 50,000 acres) and to areas beyond the Western Mountain range. Of the latter group the Northern Negev is by far the most important of the areas, being both suitable for irrigation and economically irrigable. While the northern and central areas of Israel utilise mainly local water resources for irrigation, and may perhaps be in a position to cover all their future irrigation requirements from such local resources, the Northern Negev represents an area of about half a million acres of excellent loess soil, suitable for irrigation, which is now but sparsely cultivated owing to its low rainfall, varying from 4 to 12 in. a year, and for which no other source of water, for large scale irrigation, can become available.

ALLOCATION OF WATER FOR IRRIGATION

The total annual flow of the Jordan River, before its discharge into the Dead Sea, averages about 330,000 million gallons of water, including quantities now already used for irrigation. If political considerations were set aside the following would appear to be a rational system for the distribution of the Jordan waters among the riparian states:

A. The Lebanon would draw from the Hasbani River, before it enters Israel territory, all the water required for irrigation in the Hasbani Valley, estimated at 6,500 million gallons per annum.

B. Syria would similarly draw from the Banyas River, before it enters Israel, all the water necessary for local irrigation—estimated at 4,500 million gallons per annum—and would draw from the Jordan, above Lake Tiberias, all the water required for irrigation of the Buteiha plain on the North Eastern shore of the Lake—estimated at a further 4,500 million gallons per annum.

C. Israel would divert the balance of the available water from the Northern Jordan or from Lake Tiberias—which lie entirely within her territory—amounting to about 110,000 million gallons per annum or one third of the river's total flow, and would leave in Lake Tiberias such quantities of water as are required to maintain its water level.

D. The Kingdom of Jordan would utilise the flow of the tributaries of the Lower Jordan, and particularly that of the Yarmuk River whose flow alone roughly equals the present flow of the Upper Jordan at their confluence. By high level storage of the winter flows of the various tributaries, for which suitable reservoir sites are available, and the partial utilisation of ground water, sufficient water would become available to irrigate all the lands in the lower Jordan Valley, almost entirely by gravity flow.

In this way each country could make fullest possible use of the water flowing within its own territory; all local irrigation requirements, except in Israel, would be covered and the maintenance of international controls would become unnecessary.

WORK UNDER EXECUTION

Of the major works involved in the utilisation of the Jordan water, those already under execution form part of the Israel Irrigation Scheme. The work in progress is briefly described below; some are illustrated and the locations are shown in the map.

Near the northern frontier a diversion has been constructed on the Dan River which will provide water for gravity irrigation of the whole of the Huleh Basin. In order to render this land irrigable, the shallow Huleh Lake and swamp, which cover an area of 10,000 acres, are now being drained, and the work in progress is shown in Fig. 1, which illustrates the nature of the territory. The Lake outlet has been deepened, and the

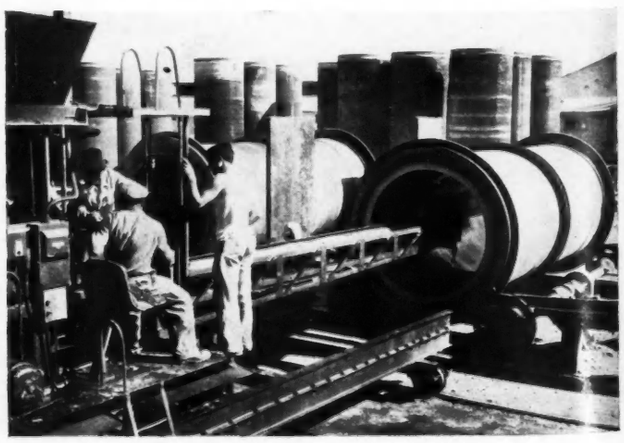

Fig. 3 Spinning concrete pipes for the secondary lines of the distribution system from the Yarkon river.

dredging of the main drainage channels is approaching completion.

Below Lake Huleh, a diversion structure has been constructed from which the water will flow through a canal, which is now under construction, at a rate of 900 cusecs, to the forebay of a 36,000-kW power and pumping station at Tabgha on Lake Tiberias. From there the water will be taken through a 700-cusec canal, to a 47,000-h.p. pumping station which will lift the water through a 108-in. diameter rising main and a 9-ft. 6-in. diameter tunnel, 3,000 ft. long, now under construction, to the central storage reservoir of the whole system in the Battauf Valley near Nazareth.

The Tabgha power station will partly utilise for power production such water as must in any case be allowed to flow into Lake Tiberias in order to maintain its level, as well as a certain part of the water intended for delivery to the Battauf storage reservoir. The water will be allowed to drop through the power station in hours of peak power consumption and will be pumped up again using off-peak power from the grid. Such a system, besides being in itself economical as a pumped-storage station, has two further advantages: it allows Lake Tiberias to serve as an additional hold-over storage reservoir for dry years, and it also makes possible a partial regulation of the salinity in the lake.

The central storage reservoir at Battauf will be developed in stages. An experimental reservoir, formed by an earth dam, shown in Fig. 2, was completed two years ago and the next stage will bring its capacity up to 65,000 million gallons, providing a satisfactory system of water-proofing pervious rock outcrops within the reservoir area can be devised. Tests of different methods of blanketing such outcrops are now under way. Its ultimate capacity is to be 220,000 million gallons. From the afterbay of the Battauf reservoir, at an elevation of 460 ft. above m.s.l., the water will flow by gravity to the Negev through two further tunnels, each 9 ft. 6 in. in diameter, totalling 5·5 miles, and 82 miles of 108-in. prestressed concrete pipe-line Towards the end of this pipe-line, at Wadi Sarar, there will be an equalising reservoir of 17,000 million gallons capacity which will allow the pipe-line from Battauf to flow full through-out the year.

About half-way to the Negev the 108-in. pipe-line passes the Yarkon River and from here it will run parallel to two 66-in. pipe-lines carrying the water of the Yarkon which, properly speaking, form part of the same overall system. The first of these lines, made up of 66 miles of "Lock-Joint" prestressed concrete and steel cylinder pipes, and including three Diesel-driven pumping stations averaging 9,000-h.p. capacity each, is now approaching completion. Spinning concrete pipes for the secondary lines is shown in Fig. 3, opposite. From the southern end of Lake Tiberias a 280-cusec canal will convey lake water for gravity irrigation of the Beisan Valley. The small triangle of land south of the Sea of Galilee, between the Jordan and the Yarmuk River will continue, as hitherto, to draw its water from the Yarmuk.

DEAD SEA POWER SCHEME

As an interesting corollary to the diversion of the Jordan water for irrigation comes the possibility of large-scale hydro-electric power production by dropping from the Mediterranean Sea into the Jordan Valley, and finally into the Dead Sea, the amount of water required to maintain the level of the Dead Sea unchanged (a matter of some importance in connection with potash and allied chemical production). As already noted, the Dead Sea is at a depth of 1,300 ft. below m.s.l. and after the diversion of all water usable for irrigation the power which can be generated continuously by the replacement water will reach a total of 105,000 kW, of which 75,000 kW can be generated within Israel and 30,000 kW within the Kingdom of Jordan. In this system, as in the case of the irrigation systems, each of the States can set up its own power plant independently of the other—except that the first step must, of course, be taken by Israel to introduce the Mediterranean Sea water into the Jordan Valley.

CONCLUSION

Irrigation and power development schemes such as the one described for the Jordan can do much to help in the settlement of the refugee problem. Still more can be done by proper development of other rivers in the area—notably the Euphrates in Syria and Iraq, the Orontes in Syria, and the Litani in the Lebanon. For here, vast under-populated areas of highly-fertile soil, and abundant riches in water, wait only the hand of man to turn them to his beneficial use.

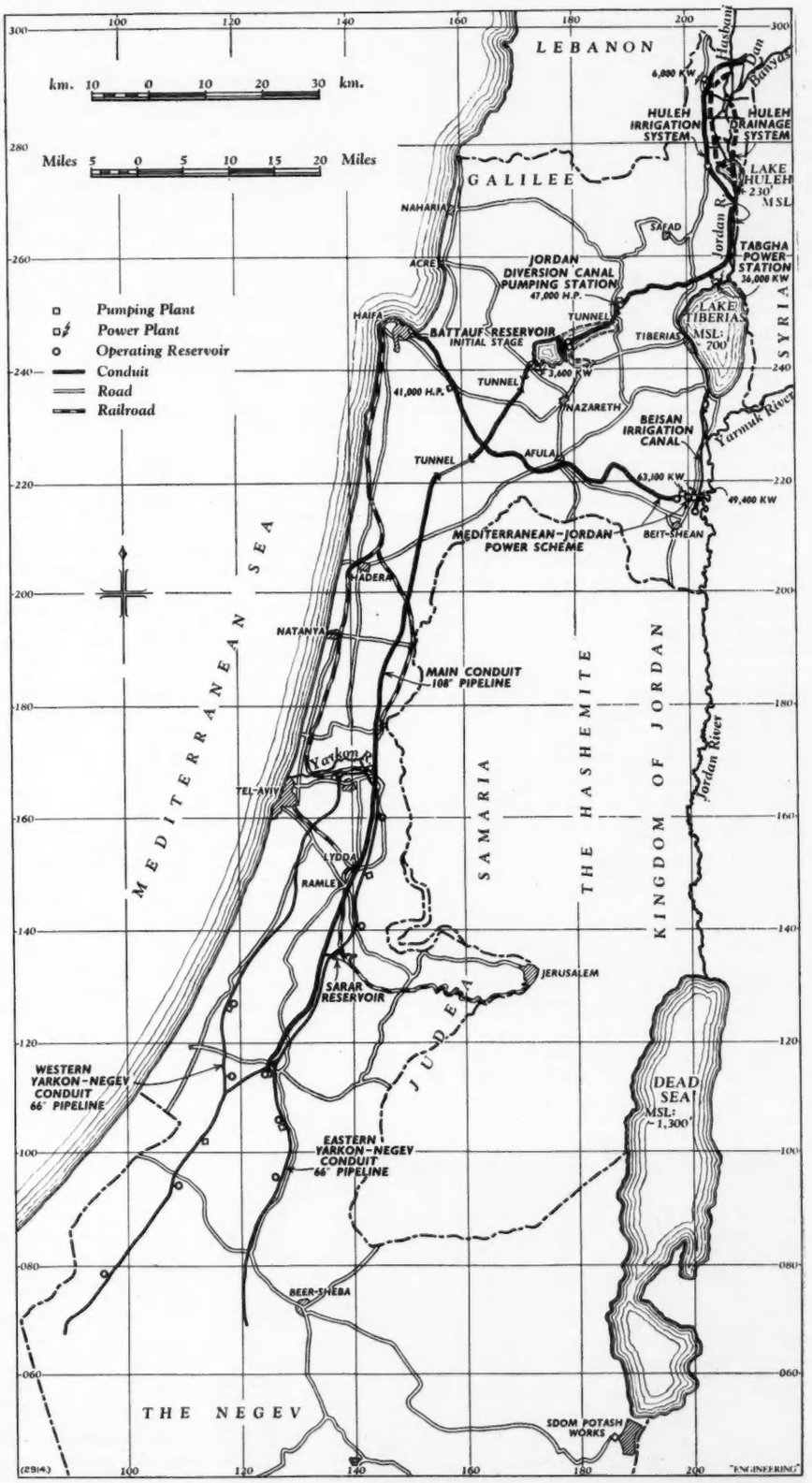

Fig. 4 Works in hand as part of the Israel irrigation scheme. The scheme has the dual purpose of enhancing irrigation and producing power for new industries.

THE CHOICE OF FLEXIBLE TUBES AND HOSES

*By J. V. Klein**

Flexible tubes and hoses form an essential part of most industrial processes, and thousands of different types are available in this country. The selection of a "flexible," however, is very often left until the last moment in the design of a machine, with the result that the machine maker has to put up with second or third best. Had he consulted makers of flexible tubing, or some form of "flexibles advisory service," he might well have simplified the design of his machine and would certainly have obtained the most suitable tubing for his needs.

Some of the working conditions which affect the choice of a flexible are listed below; it is clear from the very different circumstances under which flexibles may have to operate that the choice should be made by those with wide experience of manufacture and operation. The conditions can be summarised as follows:

Pressure.—High, low or negative internal and external pressures.

Flexing.—High or low frequency vibratory flexing; continuous or periodic mechanical flexing; manual flexing.

Temperature.—High or low internal and external temperatures.

Abrasion.—Internal or external abrasion.

Conveyant.—Air, gas, oil, steam, liquids or solids (including the complete list of chemicals).

In most of these applications the weight and strength of the hose are highly important, as is also the point of frictional loss or elongation under pressure, and costs also have an important bearing on quality and make-up. At one time it was possible to meet certain conditions such as crush resistance and higher internal pressures merely by increasing the wall thickness of, for example, a rubber hose, but such a course is not always possible or desirable today, even if the vital question of cost was disregarded.

All basic raw materials and synthetic materials so far produced have their physical limitations, otherwise flexible hose making would not be such a highly specialised undertaking. It is obvious that no one particular material can be considered a short cut to meeting all operating conditions so that in hose making it is vitally necessary to make a careful study of all the qualities of the various materials available, and to keep closely in touch with all new developments.

NATURAL AND SYNTHETIC RUBBER HOSES

To meet the conditions described above in varying degrees there are four main types of flexible tubing produced to-day, namely rubber, metallic, plastics, and composite flexibles.

This type of flexible is probably the best known of all and has many varied applications. A moulded rubber hose with cotton braid reinforcement can usually be recommended for conveying a great variety of liquids, air, gas and oxyacetylene at pressures in the region of 250 lb. per square inch. A feature of moulded rubber hose is that it can be made in continuous lengths. For heavier duty, mandrel-wrapped hose with braided cord reinforcement should be used. A mandrel-wrapped hose with wrapped ply reinforcement should also be used for steam—there are various grades for both high and low working pressures. For use with acids and other chemicals there are mandrel-wrapped and moulded hoses but the greatest care should be taken when ordering to ensure that the operating temperature and pressure and also the concentration of the chemical is fully specified.

Although the range of natural and synthetic rubbers is extremely wide it is not always possible to use a rubber flexible, as many acids and alkalis in general use tend to neutralise, wash-out or otherwise dissolve certain constituent parts of the hose material. This action can cause rapid disintegration of the hose or, at the least, result in minute particles of the hose material adulterating the conveyant.

The operating temperature for rubber-based flexibles also restricts their use in some directions. The maximum temperature is in the region of 300 deg. F., after which there is a tendency for the hose to become oxidised and brittle, while at the other end of the scale—in low temperature conditions, approximately minus 20 deg. F.—there is an early tendency to brittleness and stiffening which could cause the hose to snap if it was violently flexed.

Typical applications for rubber flexibles are in compressed air equipment, greasing equipment, hydraulics, lubricating equipment, etc.

INCREASED TEMPERATURE RANGE USING METALS

With flexible hoses constructed, for example, from metallic strip, there is a distinct advantage over most other materials in relation to the temperature range. It is possible in special cases to cater for temperature conditions up to 1,200 deg. F., but to achieve a high degree of flexibility comparable with, say, a rubber hose, it is necessary to leave the normal range of interlock metallic and resort to the more expensive seamless metallic hoses which are produced from solid-drawn tubing and formed into a helical or parallel series of corrugations.

An additional advantage with these latter type is that they are less liable to fracture or disintegrate under torsional or lateral strain which, by virtue of the principle of manufacture, are among the inherent weaknesses in interlock metallic hose. Particular care must be taken, however, not to over-flex or stretch interlock metallic hose beyond its natural bend radius. Apart from the electrical conduit type of metallic hose construction used for armouring of cable leads, the most common type of metallic flexible hose in use is the interlock strip range of pressure tubing, where, as previously indicated, the degree of flexibility is restricted in comparison with rubber, plastics, composite, or seamless metallic hoses.

The two metals most commonly used are bronze and electro-galvanised steel and most of the more commonly used liquids can be conveyed through hoses made of these metals, without deterioration to the liquid or the inner surface of the hose. There are, however, many acids and chemicals which would be unsuitable, either because they would damage the tubing itself or because they would be contaminated while passing through the metal. Stainless-steel hose is able to deal effectively with some of the more active or corrosive liquids but it has to be ruled out in many cases owing to its considerably higher cost (due to the expensive processing of the raw product and the more difficult and costly operation of forming it into hoses), and also because there is a scarcity of stainless steel for commercial needs.

Metallic hoses are manufactured to operate either under constant or infrequent flexing conditions and where high pressures are experienced an external wire braiding is usually included. Typical applications for this type of flexible include steam pressure and vacuum applications and for conveying air, gases, oils, acids, water, chemicals, bitumen, machine tool coolants, etc.

ADVANTAGES AND LIMITATIONS OF PLASTICS

This form of hose has been developed satisfactorily only in recent years and it has many characteristics not common to rubber or metallic hoses. On the credit side is included light weight, exceptional weathering qualities and the fact that with fully transparent types the cycle of operation in the free flow can be observed through the hose. Plastics flexibles are also inert to many widely-used oils, acids, chemicals, etc.

Among the disadvantages must be mentioned a susceptibility to heat. All types of plastics hoses are heat-formed; in the case of thermoplastics the operating temperatures should never approach or exceed the temperature at which the hose was originally manufactured—generally in the region of 75 deg. C. A possible danger is cold flow which can take place, often at the end fitting points, which may cause loosening, and there is also a tendency towards stiffening under low temperature conditions.

Although the resistance of plastics hoses to acids and chemicals is in general much greater than with either rubber or metal, careful consideration must be given to the conditions of application before using such flexibles. Plastics

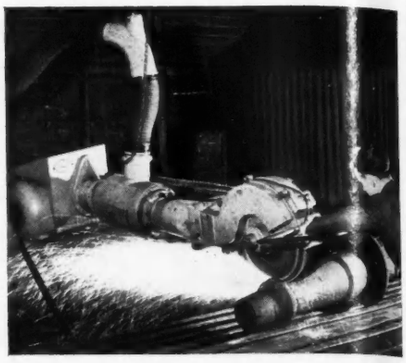

Fig. 2 Fumes and abrasive red-hot fragments of metal are conducted away from this swing-frame grinder by a 6 in. flexible lined with Linatex and covered with rubberised canvas. Under certain circumstances part of the weight of the grinder is taken on the flexible.

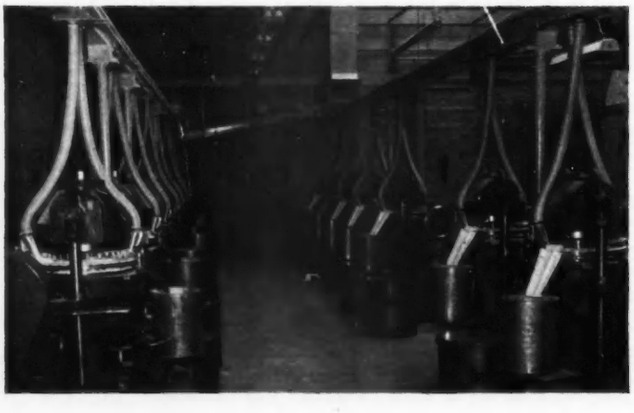

Fig. 1 Plastics flexible tubes 2 in. in diameter are used to convey powder to these tablet-making machines. Operators can see immediately the flow of powder stops, and 20 mins. per day per machine has been saved since the flexibles were installed.

* Joint Managing Director, Compoflex Company, Limited (Flexibles Advisory Service).

Fig. 3 Heavy bitumen-impregnated kraft paper is used in the heating system of this car. The 4-in. diameter tubing, which is oil and water resistant, is used to convey warm air.

flexibles also include reinforced hoses which are ideal for short fuel lines and others which can be used with fuel oil, air, water, gas and food liquids. An interesting example of a plastics flexible is shown in Fig. 1. Powder to be made into tablets is conveyed to the machines through 2-in. diameter plastics flexible tubing, and the users say they have saved 20 minutes per day per machine by substituting tubing for the previously used hoppers; part of the reason is that it can be seen immediately when the flow of powder to a machine stops.

COMPOSITE FLEXIBLES

These were really developed during the war when the shortage of such raw materials as rubber called for improvisation and a search for substitutes. The basis of a composite hose is simply one or more wire helices, and it is possible to incorporate in such a hose a vast variety of materials. After a thorough examination of the conditions under which such a hose would have to operate, and an equally thorough study of all the known materials from which it could be made, it is now possible to combine almost any known woven, pressed or formed sheet material which has the slightest pliability. The range of these materials is almost infinite and it is therefore impossible to give more than a brief indication of them or their qualities. They include canvas, cambric, asbestos, terylene, nylon, wood fibre, etc., which can be used in all weaves, strengths or weights, either in their natural form or processed by impregnation or coating with any synthetics, natural rubber or plastics which will flow under heat or pressure. Another material is heavy bitumen impregnated kraft paper, used for the 4-in. car-heater tubing shown in Fig. 3.

Consequently there is an almost unlimited choice of materials for such flexibles, and they can be used singly, combined or interleaved to provide such necessary qualities as resistance to pressure, temperature, abrasion, and vacuums, and compatibility with an enormous range of liquids including many acids previously thought to be unconveyable. Fig. 2 shows a composite flexible, 6-in. diameter, consisting of a Linatex inner lining and a rubberised canvas outer lining held between two wire helices. The tubing is being used to carry fumes and abrasive red-hot fragments away from a swing frame grinder. Under certain conditions it supports part of the weight of the grinder.

It will be realised that the fabrics are used, in the main, to form the basis and strength of the hose wall and that the impregnations or coatings give the necessary protective and resistance qualities. Where crush resistance or a constant bore are necessary the introduction of a spiral wire, either completely embedded or exposed as an armouring, not only adequately achieves its purpose, but may become an integral part of the hose, thus allowing the maximum flexibility compatible with lightness and strength.

In the actual production of composite hoses, plies of treated, coated, or impregnated fabric materials, sometimes interleaved with synthetics in sheet form, are wound on mandrels in succeeding layers—these can be few or many, according to the design planned by the development department after analysing and catering for the specific working conditions. In rough bore hoses these plies are wound over an inner supporting wire spiral and in smooth bore hoses the spiral can be either completely embedded into the plies or sunk flush with the surface. A final outer holding and armouring wire is then applied. For particular requirements the whole hose can be heat cured, so bonding the various wall plies together or, where the materials do not either require or lend themselves to curing, the outer wire can hold the plies over the inner wire to form a perfect, highly flexible and fluid-tight hose.

Most composite flexibles can be supplied with either a rough or a smooth bore. Generally speaking there is a great deal of nonsense talked about the advantages of smooth over rough bores, but as a result of experience it is reasonable to suggest that a smooth bore is of importance only when the least resistance to flow is essential or where the chemicals being carried would attack the wire reinforcement in the inside of the hose.

SELECTING FLEXIBLE TUBING

It will be seen from the above outline that there are many instances where a number of different flexibles can each be used for the same job. Often it is relatively unimportant which type is chosen and the deciding factor can be the question of cost. It must be stressed, however, that when ordering flexibles all possible information must be given to the prospective supplier so that he can appreciate exactly how the flexible is to be used and what the operating conditions are likely to be. This may appear to be elementary, but many cases come to mind of a flexible giving unsatisfactory service where after detailed investigation it is generally found to be the fault of the user who has often failed to disclose some vital factor.

When consulting any supplier for flexible tubing an engineer should always know what he wants; more precisely, he should know: the internal diameter; the external diameter, if important; the quantity and exact lengths required; the conveyant, maximum and minmum working temperatures and pressures, and details of vacuum, if applicable; type and size of end fillings; angle and periodicity of tube flexing and vibration; bend radius; if frictional loss is important, the flow required in gals. or cub. ft. per minute; general conditions of application, including external conditions.

If these details are clear in the enquirer's mind, he and the supplier will work out the best engineering answer jointly. In this way nothing is left to chance, and the results will be most satisfactory for both parties.

* * *

RESIDUAL FUELS FOR GAS TURBINES

Test Reports

Acting in conjunction with the Esso Development Company, Limited, a series of tests has been carried out by Ruston and Hornsby, Limited, Lincoln, on the use of residual petroleum fuels in gas turbines. For this purpose one of the firm's 3CT machines, was fitted with an elbow combustion chamber as shown in Fig. 1. A report on the tests carried out is given below.

In a preliminary series of tests, a number of 10-hour screening runs were carried out to explore the effect of gas temperature over the range from 620 to 770 deg. C. and the benefits to be achieved from using various additives including magnesium compounds, zinc oxide and ethyl silicate. It was found from these tests that, whilst using magnesium, a considerable reduction could be obtained in the corrosion rate without increasing deposition.

Since these initial tests, a 1,000-hour test has been carried out on a fuel containing 3·5 per cent. sulphur, together with 50 vanadium, 26 to 62 sodium and 300 total ash, the amounts being expressed as parts per million. A magnesium additive was used and the test was divided into ten, 100-hour runs. The turbine blading was water washed to remove the small amount of deposit on the blades at the end of each 100-hour run, by means of equipment built into the turbine and fed with mains water. No stripping of the turbine was necessary for carrying out the washing process and no other cleaning was required during the 1,000-hour test. The time taken for cleaning was about 2 hours. About 90 per cent. of the deposit on the first row of turbine stator blades could be removed in this way, and the turbine swallowing capacity was only 3 per cent. less at the commencement of the tenth test than at the commencement of the first.

The first five 100-hour tests were carried out at a mean gas temperature of 700 deg. C. corresponding to rather more than 90 per cent. of full load on the given machine. Fig. 2 shows the convex and concave faces of one of the first-row Nimonic-80 stator blades after removal from the turbine on completion of this period of 500 hours running. The photographs were taken by the Mond Nickel Company who examined the blade and considered it to be in a satisfactory condition for further service and free from serious corrosion.

During the next five 100-hour tests the range of temperatures between 650 and 750 deg. C. was investigated as well as changes in the additive concentration. Again the blading could be well cleaned by the water-washing. It is now intended to carry out further long tests on the Ruston 3CT gas turbine to determine the commercial possibilities of this system fully and to build up a background of general experience on the operation of gas turbines on residual fuel.

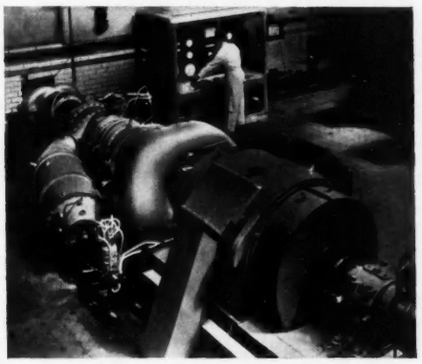

Fig. 1 A series of tests on residual petroleum fuels has been carried out on a Ruston 3CT gas turbine fitted with an elbow combustion chamber.

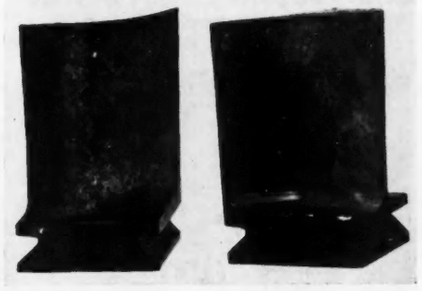

Fig. 2 After 500 hours the blading was washed with water and the first stator row of Nimonic-80 blades were removed for detailed inspection. There was very little deposit on either the convex or the concave faces.

THE BATTELLE MEMORIAL INSTITUTE

SPONSORED RESEARCH IN EUROPE AND AMERICA

In industry to stand still is to go backwards. New materials, new processes, and new concepts of factory organisation will give a cheaper and possibly more efficient and durable product than those made by the old methods. Many firms, or directors of firms, are forced to spend much of their energy on day-to-day production problems, and have insufficient time to devote to looking forward. Yet if they are to retain or enhance their prosperity, they must always be planning for the future. A great part of the future of industrial and engineering firms depends on the amount of time and money they spend on research. From research will spring the new methods and materials for their future products, and research can be extended to cover the adaptation of present to future production methods. In many cases, however, the firm is too small to afford an elaborate or even adequate research programme, and the money spent on insufficient research may be just so much money thrown away. In order to obtain exactly the results that are required, the easiest way for the small firm, and very often the big firm also, if they have not suitable equipment, is to put their problem before a sponsored-research organisation. One such organisation is the Battelle Memorial Institute.

The Battelle Memorial Institute was founded by bequests from Gordon Battelle, member of a prominent Ohio family of industrialists. When he died he willed his estate to found a research organisation that should make no profit and be for the general good of industry, and through industry, mankind. The estate and the Institute are directed by a Board of trustees, who are responsible for seeing that the terms of the will are adhered to in the running of the Institute's laboratories. The headquarters are at 505 King-avenue, Columbus 1, Ohio, and there are also laboratories at Geneva and at Frankfurt-on-Main, Germany. Before describing the two European laboratories, it is interesting to compare the general facilities for research and the place of the sponsored-research organisation in the United States of America, Switzerland, Germany and England.

RESEARCH IN AMERICA

In the U.S.A., as in all other countries, the main divisions of research laboratories are: laboratories owned by a firm and used for research into their own particular problems; laboratories run by a group of firms, generally called research associations; fundamental research laboratories at universities, technical schools and in some government departments; government-owned laboratories for matters of national interest and importance, such as those under the immediate control of the Department of Scientific and Industrial Research in this country; and privately owned and run laboratories for sponsored research.

In the U.S.A. the larger firms maintain elaborate research laboratories, and nearly half of the medium and small size firms have some sort of research facilities of their own. There are now some 2,000 trade associations of national and regional scope, many of which have research as one of their major functions. They conduct research intended to promote the trade as a whole, using either their own laboratories or engaging the services of outside organisations. There are at least 30 nationally known laboratories maintained by trade associations. This number is small when compared with the 40 or more research associations with nationally known laboratories in the United Kingdom, and considerably smaller size of our industry. But the United States Government has always been sensitive to any form of monopoly or trade association which may take a strangle-hold on a corner of the market. Trade associations for research can lead to other forms of association, which might well be to the disadvantage of the consumer. This is probably one of the reasons why the trade association is not so well developed in the U.S.A. as in the U.K., but it is gradually becoming more important.

Government and university laboratories exist in all four countries. The universities concentrate more on fundamental research, but many have found that close co-operation with industry even in this field is to their mutual advantage. The Government are sponsoring increasingly more research at the universities; while this is a financial advantage, it is doubtful whether the long-term results of Government control over research will be good. The final group is that which is most strongly developed in the U.S.A., the private research institutes operating independently of any collective organisation, of which Battelle is an outstanding example.

SWITZERLAND, GERMANY AND GREAT BRITAIN

In Switzerland the situation is very different, because of the much smaller and more specialised nature of their industries. There is a watch-making research laboratory at Neuchatel, which operates for the general good of the watch-making industry. At Zurich is a research organisation covering engineering and allied industries, but beyond these and the government and University research laboratories there are only the facilities firms have established for themselves, and the recently opened Battelle Memorial Institute at Geneva.

In Germany the pattern is more that of the U.S.A., with research associations, research laboratories owned by individual firms, and governmental and University laboratories all on a large and expanding scale. In Germany there are also the Max Planck institutes, covering a much wider field than engineering and industry only, and more concerned with basic than applied research. The sponsored-research organisation is represented by Battelle at Frankfurt-on-Main, and this laboratory and its work is described in more detail below.

Fig. 1 Laboratories of the Battelle Memorial Institute at Frankfurt-on-Main, Germany. The laboratories are on three floors, and there are a library and a lecture theatre with variable capacity.

Fig. 2 The Siemens electron microscope at Frankfurt. The greater part of the equipment at both Geneva and Frankfurt comes from Europe, and at Frankfurt as much as possible has been obtained from German manufacturers.

In the United Kingdom the feature which differentiates the conduct of research from that in other countries is the great part played by the government, working through the agency of the D.S.I.R. This does not imply that control of research is in the government's hands, although naturally in certain fields research is done at the government's request. It means rather that research is encouraged for the general good of the country, and the recently announced five-year programme for the D.S.I.R. shows that the government realises that encouragement must be continuous and stable to be most effective.

SPONSORS AND SECRECY

In all four countries, whatever the pattern of research, its main aim must be to benefit industry and through industry all the people of the country. The sponsored-research establishment appears to have been peculiarly successful in translating the results of fundamental research to the needs of industry, and thus making the benefits of new discoveries felt in a short time. Because sponsored research has a definite aim it is not led aside from a given path, even though some of the side tracks might produce very useful information. The relation between a sponsor and the Battelle Institute is such that research is directed towards a very specific end, and since the sponsor pays partly by the time taken for the project he is naturally anxious that the main aim should be always in view. The relationship between the sponsor and the institute is legally determined by a proposal and agreement drawn up before research begins, in which the project is defined, and the sponsor is told his rights in respects of any patentable discoveries made during research. It is also agreed that Battelle will not publish or make known to third parties the results or information of the research investigation unless the sponsor has given his approval. Projects are not accepted by Battelle where they have done or are doing similar work for other firms, and in this way

there is complete secrecy. In Switzerland and Germany this is most important, since the progress of some firms has depended on their trade secrets and knowledge. Indiscriminate spreading of the knowledge would be injurious to all parties, and Battelle are therefore most careful that complete secrecy is kept about all projects submitted to them. For that reason it is not possible when visiting the laboratories to learn what work is being done in a particular laboratory, or for whom it is being done.

FRANKFURT AND GENEVA LABORATORIES

The two European laboratories of the Battelle Institute, at Geneva and Frankfurt, are different in size, but the general organisation is the same. The Geneva laboratory, with a staff of 95 who are engaged on research in the broad fields of physics, chemistry, and metallurgy, was formally opened early this year, and the Frankfurt laboratories about a year earlier. There are at present about 245 people employed at the Frankfurt laboratories, of whom more than half are scientific research workers. An illustration of the building is shown in Fig. 1. The laboratories are on three floors, although there are certain places where the ground-floor laboratory rises to the full height of the building, thus allowing space for constructing pilot plants for various projects. There is a library, which contains a comprehensive collection of current scientific literature; this cannot cover all the requirements of the research workers, and a much more elaborate information service is maintained at the Institute's headquarters at Columbus. There information can be found or obtained on any scientific subject, and scientists at Geneva and Frankfurt can call on the Columbus information services when they have need. In the Frankfurt building there is a lecture theatre with variable capacity, and with provision made for further extension as the work and staff of the laboratories grow.

FLEXIBILITY OF LAYOUT

The most striking feature of the laboratories is the flexibility of the layout. The construction of the buildings, both at Geneva and Frankfurt, is such that the space required for a new project is allocated to that project, and walls are knocked down or built up to provide the exact space necessary. The only permanent walls are in fact the four outside walls and those adjacent to the stairways. Electricity supplies are brought up from the basement, and run along the central corridors in bus-ducts, from which tappings can be taken wherever necessary. The rating of the conductors in the ducts is generous, so that no additional installation will be necessary for any contemplated loads. Other services, hot and cold water, gas, and compressed air, come up from the basement in risers spaced along the outside walls at intervals of about 25 ft., each in distinctively coloured pipes. It is not a very big operation, therefore, when services are required for say two small projects where there had previously been one large one, to tap off the duplicate supplies. In the large hall containing the furnaces used for metallurgical research there is a ventilation duct to which can be attached the chimneys of any new furnaces that may be installed.

It is not possible to mention specific projects which are being undertaken at Frankfurt, but the general fields of activity are physics, chemistry, mechanical engineering, metallurgy, and ceramics. In Fig. 2 is shown the Siemens electron microscope, which has a magnification of 131,000. Equipment for both laboratories has been obtained as far as possible from European sources, and at Frankfurt the emphasis is on German products. Geneva, being more international in character, and not being able to purchase much equipment from national firms, has gone to Great Britain, Holland, France, and Germany for various items. Certain things come from America, but they are the exception. In Fig. 3 is shown distillation apparatus in the Frankfurt chemistry laboratory. The framework to which the equipment is attached is another example of the layout flexibility. Running along the ceilings at frequent intervals are metal T-shaped channels, which can be used to support lighting fittings or frameworks of the type shown here.

LABORATORY STAFF

The international character of the Geneva laboratory and the more German character of the Frankfurt laboratory are demonstrated in their respective staffs. The staff at Geneva are drawn from several countries, mainly European, but including one from China and one from Australia. The staff at Frankfurt are all German, with the exception of two Austrians and an Italian. There are no American research workers in the European laboratories, but the administrative International Division at Geneva has Americans on its staff. Workers are recruited to Battelle either by advertisement or by personal recommendation. It is quite clear from even the briefest tour of the laboratories that they form happy and co-operative teams, and it is this atmosphere which is part of the attraction in working for such an organisation. Some of the projects at the laboratories are of a long-term nature, but the majority at the moment are short-term, lasting for a few months. The work is therefore varied, which is both stimulating and interesting for the research workers.

The headquarters of Battelle at Columbus are many times larger than the European laboratories, and employ a staff of nearly 2,500, of whom about two-thirds are research workers. The fields cover almost all branches of engineering and fundamental sciences, including, among other things, engineering economics, fuels and combustion, plastic, rubber and paints, and nucleonics. The illustration in Fig. 4 shows the gamma-radiation source at present being installed at Columbus. Initially the source will consist of 2,000 curies of cobalt-60, and can be used for a wide variety of studies, among them the radiation sterilisation of certain foods, drugs and medical supplies, and the effects of radiation on electronic components, lubricants, and engineering construction materials.

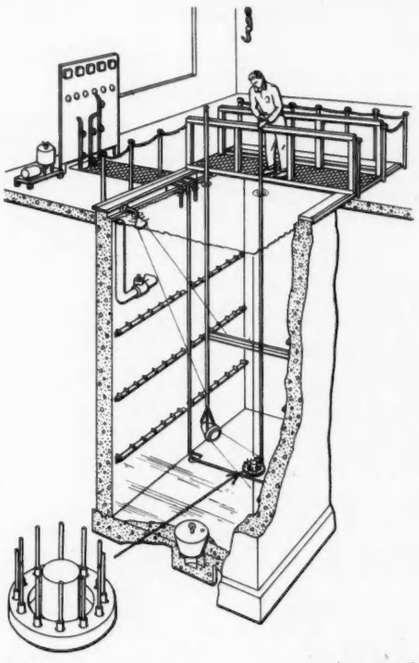

Fig. 4 A drawing showing the gamma-radiation facility at the Columbus headquarters of Battelle. The detail at bottom left shows the arrangement of steel tubes which contain the radioactive source, initially 2,000 curies of cobalt.

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LONDON BUILDING EXHIBITION

Special Display on Timber

The 26th Building Exhibition will be held at Olympia, London, W.14, from Wednesday, November 16, to Wednesday, November 30, 1955, when an extensive range of materials, plant and equipment, covering some 50 trades associated with building, will be on show. There will be more than 600 stands, occupying an area of 350,000 sq. ft. and representing about eight miles of exhibits.

Held every second year, the exhibition aims at introducing to the industry improved techniques, recently-developed materials and new methods of construction, as well as a wide variety of mechanised equipment. At each exhibition, a special display dealing with recent developments in some basic building material is arranged. In 1953, prestressed concrete was dealt with in this way and a number of firms will be individually exhibiting that technique at the coming exhibition, at which a special feature will be made of the use of timber in building.

One section of this year's exhibition will be devoted to wood-working machinery and another will illustrate modern techniques for the construction of houses, schools and industrial buildings. These exhibitions were begun in 1895, and they are still being arranged by the same organisation, the offices of which are at 4 Vernon-place, London, W.C.1.

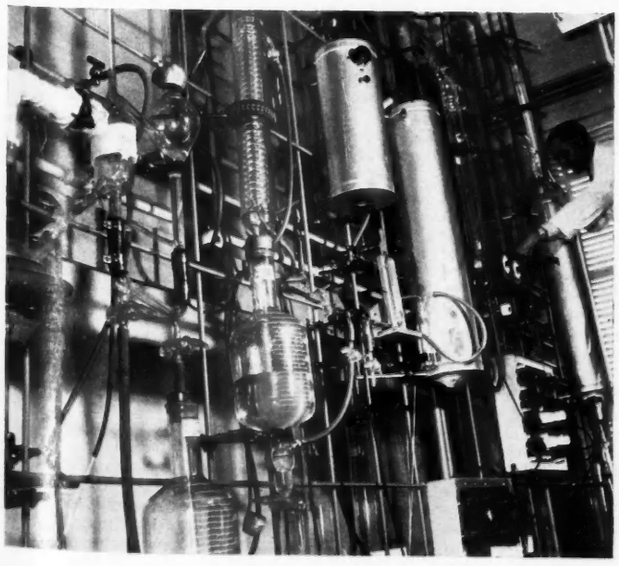

Fig. 3 Distillation apparatus in the Frankfurt chemistry laboratory; the framework is attached to T-shaped channels set in the walls, which give complete flexibility for laboratory scaffolding.

"ENTERPRISE FOR VISION"

The Development of an Important British Industry

Although spectacles have been made for many centuries, at first in a crude form mainly to assist a few elderly and learned people to read, it is only within the last century or two that they have been available for the correction of other defects in vision and their use has become almost universal. By the beginning of the present century, the greater part of the domestic demand for spectacles was met by imports from Continental countries and America, but the need for a home industry became apparent during the first World War, and a self-contained British optical industry sufficient to meet war requirements was built up. After the conclusion of the war a private company was formed to supply the domestic demand for spectacle lenses. A factory at Bittacy Hill, Mill Hill, which had been used for the production of optical munitions, was acquired and operations were commenced in September, 1919. Other lens-making firms were absorbed in the new company, known as the United Kingdom Optical Company, Limited, and although the prejudice against British-made optical goods was a formidable obstacle in the early days of its existence, the preliminary expenses incurred had been paid off by 1923 and the company declared its first dividend in the following year.

BIFOCAL LENSES

About this time, the plant and tools for the manufacture of a new type of fused bifocal spectacle lens, having a flat top to the reading segment and known as the Univis bifocal, were installed. These lenses were soon being exported in substantial numbers to America and Continental countries, but in 1926 an agreement was entered into with an American optical firm for the exclusive manufacture and sale of Univis bifocals in the United States. Progress at the Mill Hill factory had been continuous and by 1930 over 250 persons were employed there. As the demand for the company's products steadily increased the manufacturing resources at Mill Hill became inadequate. To finance the new building required, the original company was wound up and a new public company of the same name was formed, the arrangements being completed in January, 1936. Soon afterwards, discussions were commenced with Taylor and Ustonson, Limited, a firm that had been engaged since the end of the first World War in the manufacture of certain special types of lenses. As a result, the two firms were amalgamated and the special lenses were added to the production schedule at Mill Hill. At about this time a subsidiary company, U.K. Lens Distributing Company, Limited, was formed to take charge of the sales and distribution of the company's lenses in the home market. The firm's efforts to develop their export trade, however, were by no means neglected in the meantime, and trade relations with other countries than the United States, notably Australia, had been established.

As would be expected, the outbreak of the second World War in 1939 profoundly affected the firm's business. Optical components in ever-increasing quantities were vitally needed and the firm, as one of the country's main producers, was called upon to help to meet the demand. By 1942, additional factory space had to be found and a new building was erected. In the following year the firm assumed responsibility for the production of the optical components of the gyroscopic gunsight used in aircraft. For this work a factory at Leyton was requisitioned, equipped and staffed.

SPECTACLE FRAMES

Soon after the end of the war an ambitious post-war development programme was formulated and to implement it the firm's nominal capital was increased to £300,000. In 1946 a large factory at Lurgan in Northern Ireland, originally built for the repair of aircraft, was taken over. This factory, which had been used for a short time for the manufacture of spectacle frames, was equipped with new plant for the production of both lenses and frames, the latter being almost a new venture for the firm. In the following year their products were further extended to include laminated safety lenses by the acquisition of the share capital of Salvoc, Limited, and later in the same year some special frame-making processes were imported from an American manufacturer and used for speeding up metal-frame production at Lurgan. By March, 1948, new finance was needed and an additional 200,000 shares were issued. A large extension to the Lurgan factory was made. A year later the firm's nominal capital was increased to £500,000 and soon afterwards a new company was formed in Australia, known as the United Kingdom Optical Company (Australasia) Pty., Limited.

OPHTHALMIC INSTRUMENTS

A further extension to the firm's range of products, in the form of a series of ophthalmic optical instruments, was made towards the end of 1949 when a controlling interest in Allied Instrument Manufacturers, Limited, was acquired and the next important step was the amalgamation, under a single holding company, with a group of old-established ophthalmic prescription houses controlled by J. and H. Taylor (Holdings) Limited. The nominal capital was increased to £750,000. The last development to be recorded occurred as recently as April 1, 1954, when the business of the Emerson Optical and Manufacturing Co., Ltd., Finchley, was acquired.

This year the firm, now employing over 1,000 persons, has attained the 35th anniversary of its foundation and has recorded the principal events in its relatively short history in a book entitled *Enterprise for Vision*, from which we have extracted the facts given above. It will be evident from these that its activities, which have met with a great measure of success, have been directed mainly to the improvement of vision. Its affairs, however, have also been conducted with vision which has shown the importance of cultivating a strong team spirit among the management, staff and employees, and although many individuals have played their parts in bringing the enterprise to its present position, it has been achieved mainly by enthusiastic team work throughout the whole organisation. To give, in conclusion, an idea of the present magnitude of the enterprise it may be mentioned that in the past year its products, in addition to supplying about a third of the home demand, have been exported to over 50 Empire and foreign countries.

ENGINEERING MODELS AND APPARATUS

DISPLAY AT I.C.E. CONVERSAZIONE

The conversazione of the Institution of Civil Engineers was held at the London headquarters on Thursday, June 23. The members and their ladies were received in the Great Hall by the President, Mr. David M. Watson, and by Mrs. Watson. During the evening, two piano recitals were given by Miss Iris Loveridge.

An exhibition of engineering models and scientific apparatus, provided by members of the Institution, was displayed in the library. In all there were 28 exhibits, ranging from dioramas and architectural models of works recently completed or under consideration to models of engineering equipment and examples of apparatus used in current research. Descriptions of some of the exhibits are given below.

HARBOUR WORKS

Among the dioramas of work at present under construction was one showing the improvements at Colombo Harbour, Ceylon. The work there involves the provision of 15 alongside deep-water berths and two coaster berths, as well as an oil dock with a floating oil boom. The model was exhibited by Mr. R. D. Gwyther, C.B.E., M.C., senior partner of Messrs. Coode and Partners of Victoria-street, London, the consulting engineers for the project.

In greater detail, the scheme comprises the construction of the Mutwal Quay, 1,242 ft. in length, alongside the north-east breakwater; the construction of the North Pier, 1,078 ft. long, and the South Quay, 775 ft. long, to form the oil dock; the new coaster berth, 417 ft. in length, alongside the canal basin; the Delft Pier, providing a total of 3,162 ft. of quay; the widening of the quay between the new Delft Pier and the coaster berth, and the construction of the Customs Quay, 3,000 ft. in length, alongside the south-west breakwater. Except in the case of the coaster berth and quay widening, which are of cylinder construction, all the quay walls are being constructed of pre-cast concrete blocks, having an average weight of 10 tons each, set in sloping bond and founded on a rubble base approximately 5 ft. thick. The dredged depth alongside the quays varies from 32 to 36 ft. below low-water spring tides.

On the Mutwal Quay two transit sheds, each 400 ft. long by 90 ft. wide, are provided, with an office block between the two sheds. There are four transit sheds on the Delft Pier, two 540 ft. and two 480-ft. long by 110 ft. wide, while on the Customs Quay four transit sheds 500 ft. long by 110 ft. wide are being constructed. A warehouse, 300 ft. long by 200 ft. wide, is sited on the land between the Mutwal Quay and the Oil Dock. All the sheds have structural steel columns and single-span steel roof trusses. The works, which are being carried out by Compagnie Industrielle de Travaux and Etablissements Billiard of Paris as contractors, were started in June, 1950 and are due to be completed at the end of 1955.

PRESTRESSED GRAVITY DAM

A model depicting a modern constructional technique—that of prestressing a mass concrete dam—was exhibited by Messrs. Babtie, Shaw and Morton of Glasgow, the consulting engineers to the North of Scotland Hydro-Electric Board. Accompanying drawings showed how the high-tensile steel bars are being anchored into the foundation rock.

The model related to the Allt-na-Lairige Dam at present under construction in Argyllshire, Scotland, for the North of Scotland Hydro-Electric Board. It is the first prestressed concrete dam to be undertaken in Western Europe.

The novel feature of the dam is that it will be securely anchored to the rock foundation by high-tensile steel bars. By this means a more slender structure will be obtained than would be possible with a dam of orthodox design, which possesses stability solely by virtue of its weight. There will be a saving of about 40 per cent. in the volume of concrete required—an important advantage having regard to the cost of transporting cement and other materials to remote areas. The steel bars will be concreted in pits excavated deep in the rock. The bars will extend vertically through the dam and at the top a stressing load of 1,175 tons will be applied by jacking each group of bars. The groups of bars will be spaced about 21 ft. apart throughout the length of the dam across the valley, and the total anchorage load which will be applied to the rock foundation will be 54,000 tons.

Apart from economic considerations the method adopted has a number of technical advantages. For example, the compressive strength

exerted on the concrete of the dam itself through the steel bars will counteract tensile stresses on the water face of the dam when the reservoir is full and thereby ensure a more watertight structure. The contract is being carried out by Messrs. Marples, Ridgway and Partners, Limited, London.

HELICAL FLOW IN RIVERS

A visual demonstration of the growth of helical motion of a stream in a curved channel showing how one river bend may control the form of flow in another and how both can be controlled from far upstream, was given by Mr. T. M. Prus-Chacinski, formerly of the Hawksley Hydraulic Laboratory of the Imperial College, London, where the followng work was done under the guidance of Professor C. M. White.

Using coloured tracers injected into the water stream the model showed that along a curved channel the water tends to follow a helical path, the flow near the bed being deflected greatly towards the inner wall while the upper-water drifts gradually towards the outer wall. This phenomenon was observed by Leonardo da Vinci in the Fifteenth Century and was first investigated scientifically by Professor J. Thomson in this country who, in 1876, gave a substantially correct explanation of the origin of the helical flow. The motions are difficult to measure, however, and are even more difficult to express mathematically so that, until recently, very little further progress was achieved despite its practical significance, concerning as it does the fundamentals of the transport of silt and the meanderings of rivers—a field always of vital interest in river-control or irrigation.

The helical flow in the bend is mainly generated by the centrifugal superelevation of the water surface towards the outer wall, in conjunction with friction which greatly decelerates water flowing very near the bed. Centrifugal force, proportional to the square of the velocity, causes the fast upper-water to heap up against the outer wall, and the resulting pressure squeezes the slow-moving lower-water towards the inner wall. In effect, the path of the water is a screw or helix of non-uniform pitch and, in general, the magnitude of the difference of speeds of upper and lower water governs the strength of the resulting helical component of the motion.

In its bearing on civil engineering the aim of the present investigation is to guide the design of works adjacent to the bends of rivers and canals, particularly those which carry much silt or those with beds liable to scour. The motion in a bend would appear to be very sensitive to any spin or irregularity which may exist in the water before it enters the bend.

Among the more interesting findings, some possibly never previously stated, or indeed observed, are the following. The helical component, once it has developed, dissipates very slowly and so persists for great distances, and it is very sensitive to the presence of any cross currents which may happen to exist at the entrance to the channel. The helix causes great variation in the rate of transport of silt in different parts of the bend, and governs the pattern of erosion and deposition. Helical motion occurs both with rough and with smooth beds, and in bends of any cross section, and patterns consisting of multiple helices are frequent. And, finally, it has been shown that helical flow can be controlled artificially by vanes or other devices.

While at the present stage of the work it is recognised that it would be premature to describe its application to particular river works, yet it is evident that there is a wide field in which it could have a considerable influence on design.

ANALYSIS OF PLASTIC COLLAPSE

The analysis of complex structural frames by the use of models is now well established. Models designed specifically to represent the conditions at or near to ultimate failure are not, however, so well known, but a most interesting example was exhibited by Professor J. W. H. King and Mr. D. E. Jenkins of Queen Mary College, London. In particular this model employed an exceedingly neat novel hinge which incorporated small calibrated Eulerian struts; collapse of the struts, which were arranged to give lateral support to the beam and columns of the model, gave an indication of formation of "hinges" in the structure, and a measure of the moments effective at the hinge.

When a simple strut is end loaded, the curve of longitudinal deflection against load follows the same general form as that of rotation against moment for a beam subjected to a bending moment increasing into the plastic range. Hence by using such a strut as a restraint on the movement of a free hinge, such a hinge can be caused to behave in the manner of a short length of beam so loaded as to pass beyond its elastic range, i.e. as a "plastic hinge." The moment at which the plastic condition develops can be controlled by the strut stiffness and the leverage used, so that a variety of relative stiffnesses of members is readily obtainable. Furthermore, although the model simulates plastic failure, it is in fact behaving elastically throughout, and the tests are non-destructive. Repeated tests with modifications to particular members are therefore readily carried out.

The model shown at the conversazione represented a typical two-dimensional stiff-jointed frame with the plastic hinges just described fitted at the frame connections at which bending in the plastic range was liable to develop under overload. Free distortion of the frame was ensured by incorporating ball bearings under the hinges so that the model moved freely over the supporting table. In the form that the model was exhibited, the frame allowed 159 possible modes of collapse to be considered in a theoretical approach.

SUBSTANTIATING RIVER MODELS

Perhaps the most interesting—and important—river model ever constructed was that built by Professor A. H. Gibson to investigate the problems of the River Severn. Among the exhibits at the Institution was one presented by Mr. H. D. Morgan of Sir William Halcrow and Partners which comprised some plans and sections of part of the River Severn made by Captain Beechey, R.N., F.R.S., in 1849. In 1927, 78 years after they were originally drawn, they were used to substantiate the accuracy and value of Gibson's Severn model and, probably more important, assisted to establish the value of such models generally.

To do this, the sections of the model corresponding to those of Beechey's survey were shaped to the conformations of 1849. The model was then made to simulate the number of tides that occurred during the intervening period of 78 years and the resulting movements of the model bed compared with those that had in fact occurred in the river itself. The closeness with which the river bed of 1927 had been reproduced did much to establish the model as an accepted means of investigating the proposals that were being considered at that time.

MEASURING SLIPPERINESS

Two pieces of equipment were exhibited by Mr. C. E. Dunton, chief civil engineer of the London Transport Executive. They were a slipperiness measuring machine and a moisture tester for determining the water content of soils, concrete aggregates and other similar materials.

Floor surfaces inside buildings are normally smooth in character and consequently potentially slippery, and the slipperiness measuring machine has been designed to give a measure of slipperiness corresponding more closely with that experienced by the heel of a person walking than can be obtained from the static coefficient of friction tests commonly used in its assessment.

The machine consists of an A-frame from which is suspended a pendulum with a metal block at its lower end. Into this block can be inserted standard "heel" squares of rubber, leather or steel in such a way as to present a heel-like edge to samples of floor surfaces. Released from a certain constant height above the floor, the pendulum falls and the inset heel brushes against the floor. The heel square itself is set at approximately 10 deg. to the horizontal, that is to say presenting very much the same angle of contact as the shoe of a walking person presents to the floor. The heel is pressed against the floor throughout its arc of contact by a spring and the height to which the pendulum rises at the end of its swing can be noted against an angular scale by means of a pointer which swings with the pendulum and remains at the greatest extent of the swing. This reading gives a measure of the coefficient of friction between the material of the heel and the floor sample.

The machine, which is fitted with levelling screws and an inset level, can be used to determine the slipperiness of sample tiles, blocks or pieces, or for *in situ* tests on floor surfaces.

DREDGING RIVER MUD

A model of a vessel designed for the disintegration and removal of compacted mud from ships' berths, campsheds, dock entrances, etc., by the discharge through specially designed nozzles of a mixture of air and water at high pressure was shown by Mr. H. Randal Steward, chief engineer, the Proprietors of Hay's Wharf, Limited. The vessel is 63 ft. long by 20 ft. beam by 3 ft. 9 in. draught, with a working depth up to 30 ft., and it is self-propelled.

The equipment comprises two air compressors, two two-stage centrifugal water pumps and an auxiliary set with general service pump, all driven by separate Diesel engines, a starting air compressor and lighting generator. Engine cooling is by closed circulation through large radiators mounted on deck. The crane jib lifts the nozzle frame and automatically stows the air and water hoses. The nozzle frame can be rotated under power at any depth.

This vessel is the prototype of an improved and enlarged version of an existing similar craft, "Jean," which has been in operation on the Thames for the past ten years. One of its most interesting and successful achievements was the recovery of a dock gate from the North-West entrance of the Surrey Commercial Dock that had been blown up by enemy action and which had sunk in the river. The "Jean" blew a hole 15 to 20 ft. deep by some 80 ft. dia. in the mud on the river bed so enabling the dock gate to be recovered by floating crane. Illustrations of the vessel at work on various jobs were also shown during the evening.

The above descriptions, though covering a representative selection of the exhibits at the conversazione, do not fully indicate the range of the display. Soil mechanics apparatus was shown by Dr. H. Q. Golder; the department of engineering at Cambridge University, through its head Professor J. F. Baker, showed no less than seven examples from current research; two of the Regions of British Railways were represented, as were Government offices by the Admiralty and the Ministry of Works as well as by two laboratories of the Department of Scientific and Industrial Research—the Road Research Laboratory and the National Physical Laboratory. Overseas projects included a model of the new Iddo bridge for Nigeria, shown by Ove Arup and Partners, and dioramas of the British Petroleum refinery at Aden, and of the new water-supply scheme for Tehran. Finally, it may be said, the wide variety and scope of the exhibition portrayed the diversity of activity and interests of civil engineers to-day.

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STAYTHORPE B POWER STATION

The Central Electricity Authority has received the consent of the Minister of Fuel and Power to the construction of a second power station at Staythorpe, Newark. To be known as Staythorpe B power station, it will have a total installed capacity of 360 MW made up of six 60-MW turbo-alternator sets each served by a boiler having an evaporative capacity of 550,000 lb. of steam an hour.

The Staythorpe A power station, which began production early in 1950, will also house six 60-MW sets—four of which are in commission. The evaporative capacity of each of the 18 boilers in this station—13 are already in commission—is 240,000 lb. of steam an hour.

PROGRESS ON THE 275-KV NATIONAL GRID

THE KEADBY-MONK FRYSTON LINE OF THE CENTRAL ELECTRICITY AUTHORITY

The first 275/380-kV double circuit transmission line, employing twin phase conductors each with a copper equivalent cross section of 0·4 sq. in. has recently been completed between Keadby and Monk Fryston in Yorkshire and will form part of the national super grid system of the Central Electricity Authority. This line, which is 25 route miles long, was erected by Watsham's Limited, Reading, Berkshire, the contract being completed in only twelve months from the date of release of access routes to the first sites. This was particulary creditable because the bad ground conditions and adverse weather caused frequent bogging down of the mechanical transport, including the crawler tractors.

The work included the erection of 1,550 tons of tower steelwork on concrete foundations, 1,500 cub. yards of concrete material and 10,000 cub. yards of soil excavation. The steel-cored aluminium conductors, which weighed over 800 tons and were 325 wire miles long, were run out over difficult ground, erected and sagged on the towers.

TOWER FOUNDATIONS AND STRUCTURES

The wide base tower foundations consist of four separate concrete block footings which are planted at depths ranging from 10 ft. 3 in. to 15 ft. 7 in. on level ground according to the type of tower. The amount of excavation necessary to accommodate these foundations ranged from 65 cub. yards per site for the intermediate suspension towers to 187 cub. yards for the heavy angle towers up to 60 deg. deviation of line. The corresponding concrete volumes per site varied from 8·9 cub. yards to 34·5 cub. yards. During excavation large quantities of water were encountered thus necessitating heavy pumping and in many instances the use of special dewatering equipment.

The tower structures, which were fabricated by William Bain and Company, Limited, Coatbridge, and Redpath Brown and Company, Limited, Glasgow, consist of galvanised mild and high tensile steel sections. They range in weight from 10¾ tons for the suspension to 29·33 tons for the terminal towers, the overall height varying from 136 ft. 6 in. to 144 ft. 6 in. Fig. 1 is a view of an intermediate suspension tower, while Fig. 2 illustrates a light angle tower up to 10 deg. deviation of line. The towers were designed for an average span of 1,200 ft. and a maximum of 1,760 ft., the minimum conductor to ground clearance being 25 ft. with sags of 40·31 ft. in a 1,200-ft. span at a temperature of 122 deg. F. in still air. To take advantage of the ground contours, the heights of some of the towers vary from 24 ft. less to 36 ft. more than the standard height. The towers are designed for a factor of safety of 2·5 under maximum simultaneous working loadings and 1·5 as modified by assumed breakage of conductors. The conditions applied to the different types of tower are: one broken twin conductor for suspension towers and three broken twin conductors in any one span for both angle and terminal towers.

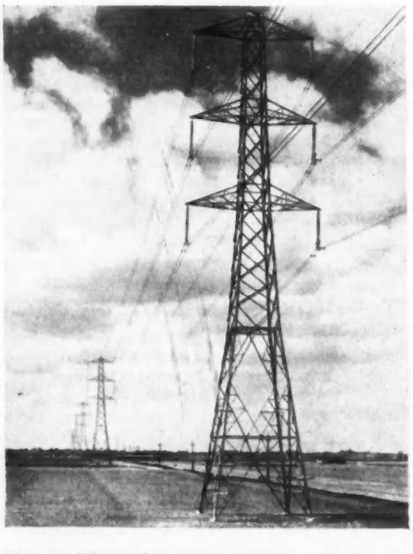


Fig. 1 View of an intermediate tower on the 275-kV line of the national super-grid between Keadby and Monk Fryston in Yorkshire.

CONDUCTOR DESIGN AND ERECTION: SPECIAL SAGGING TECHNIQUE

Each of the two circuits consists of three pairs of steel cored aluminium conductors, which were manufactured by the Aluminium Wire and Cable Company, Limited, Port Tennant, Swansea. The two conductors forming a pair each consist of 61 strands 0·125 in. in diameter, 54 being of aluminium and seven of steel and are spaced horizontally at 12-in. centres. The maximum working tension per conductor at the worst loading condition is 12,000 lb., with an average erection tension of about 6,000 lb. In addition to the twelve line conductors, an earth conductor, consisting of 30 strands of aluminium and seven of steel, is run along the top of the towers.

The erection and sagging of the conductors presented certain practical problems. Instead of running out the single conductors manually with the assistance of wheeled tractors, heavy crawler tractors were employed. It was thus possible to run up to four conductors simultaneously over a number of straight spans thus favourably affecting the rate of progress. Another difficulty was that the specification required that the sag of any one line conductor after final erection should not vary by more than 6 in. from the mean sag in the same span, while the difference in the sag of the twin conductors forming one phase should not exceed 1½ in. In addition, a linear adjustment of ± 3 in. had to be allowed for in the length of the individual conductors at the end of the one year's maintenance period. To meet these conditions, a new sagging technique was developed; and special sag adjusters, consisting of galvanised mild steel links, were inserted between anchor points on the tower cross-arms and tension insulator sets. These adjusters, which are shown at *a* in Fig. 3, have been specially designed to permit linear adjustment over a total of 13¾ in. in ¼-in. steps.

To prevent clashing of the twin conductors due to the wind and resultant vibration, mechanically-hinged spacers were inserted at pre-determined intervals. Depending upon the span up to six spacers are fitted per twin conductor. In Fig. 3 a spacer is indicated at *b*, while the vibration dampers, which were manufactured by Switchgear and Equipment, Limited, Banbury, and arcing horns are shown at *c* and *d* respectively.

INSULATOR SETS AND FITTINGS

The insulator strings employed on this line were manufactured by Pilkington Brothers, Limited, St. Helens, and consist of toughened glass units connected by ball and socket joints. Suspension sets are made up of single strings of 18 discs, the overall length being 11 ft. 10 in. and the weight 404 lb. including fittings. The tension insulator strings on the angle and terminal towers, consist of duplicate strings of 16 units each, their overall length being 10 ft. 5 in. and their weight 647 lb. Figs. 1 and 2 show the two types of insulators. The conductors are supported by galvanised Meehanite cast-iron trunnion type clamps at the suspension points, while aluminium compression dead-end clamps are used at the anchor positions. Compression type mid-span joints are employed in selected positions to connect the conductors which were supplied on standard drums or in specified section lengths. These fittings were supplied by the Northern Aluminium Company, Limited, Birmingham.

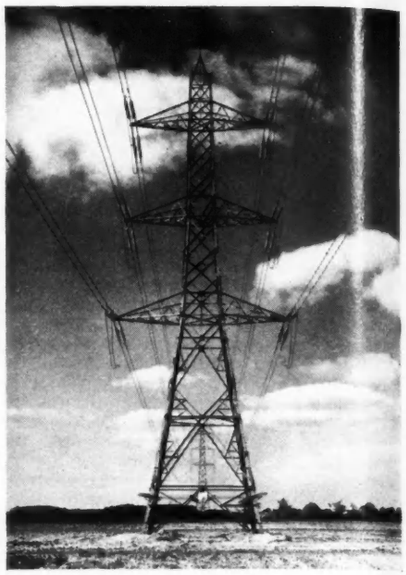


Fig. 2 A 10-deg deviation tower showing the duplicate insulator strings.

The line has been insulated for 275 kV nominal voltage between phases, but in designing the towers, provisions have been made to increase this to 380 kV. When working at 275 kV, the carrying capacity of the line will be about 1,000 MW.

Fig. 3 Top of a tower illustrating duplicate insulator strings and fittings:
***a* Sag adjuster sets. *c* Vibration dampers.**
***b* Spacer. *d* Arcing horn.**
The mechanically-hinged spacers are inserted at intervals to prevent clashing of the twin conductors.

WIND-DRIVEN GENERATOR ON COSTA HEAD

OPERATIONAL EXPERIENCE AT VERY EXPOSED SITE

Costa Head in the Orkneys is one of the windiest and most exposed places in the British Isles. Because of the wind it is eminently suitable as a site for a wind-driven electric generator, but because of the exposure the conditions for construction are formidable. In spite of the difficulties, the 100-kW plant shown in Fig. 1 has been erected there by John Brown and Company (Clydebank), Limited, Carlisle-street, Sheffield, 4, for the North of Scotland Hydro-Electric Board. The plant has been running in parallel with the Diesel generators on the island at various times over the last year; because the plant is largely experimental, however, there have been continual modifications in the light of field experience, and operational running has not been continuous. John Brown and Company are now working on a design for a 250-kW wind-driven generator and experience gained from the first machine will greatly reduce constructional and operational problems in the second.

The Costa Head windmill has been designed to give an output of 100 kW with a rated wind speed of 35 m.p.h. The height of the triangular-section steel tower is such that the centre of the rotor is 78 ft. above the ground, and swept diameter of the three-bladed rotor is 50 ft. The nacelle mounted on top of the tower, shown in Fig. 1 and diagrammatically in Fig. 2, carries the three-bladed rotor, step-up gearbox with clutch, and electric generator; in addition, it carries the pilot windmill, yawing vane, and control gear, which together position the blades appropriately in relation to the wind and keep the rotor shaft turning at the correct speed. The output from the generator is 3 phase, 415 volt, and is fed through slip rings and cables running down the side of the tower to the transformer shown at the foot of the tower. From there the output is fed to the main distribution network of the island through the 11-kV line also shown in Fig. 1.

TOWER AND FOUNDATIONS: DESIGN FOR HIGH WIND LOADING

To withstand the exceptionally high winds—gusts sometimes exceed 125 m.p.h.—great attention has been paid to the construction of the tower and its foundations. For a depth of 6 ft. below the surface the ground consists of soft rock. An excavation 6 ft. 9 in. deep was made at each of the three points where the legs of the tower stand, and from the bottom of each excavation eight holes 4 in. in diameter and 6 ft. deep were drilled in hard rock at an angle of 20 deg. to the vertical, equally spaced on a 3 ft. 9 in. square. Mild-steel rods 1 in. in diameter and 9 ft. long were grouted into these holes, and the excavation was then partly filled with concrete, giving a block 6 ft. square at the base and 4 ft. square at the top by 2 ft. 6 in. thick, the top being 4 ft. 3 in. below ground level. A steel plate 2 ft. square by 2½ in. thick was fixed to the block, the mild-steel rods acting as foundation bolts, and the leg of the tower was firmly cleated to this baseplate. More concrete was poured in to cover the plate and to case the tower leg to above ground level, and finally the hole was filled in with some of the excavated material.

The tower is constructed from steel angle sections, galvanised after fabrication. It is triangular in section, the width of each side being 24 ft. at the base and 7 ft. 10½ in. at 66-ft. level. The total height from the ground to the seating for the bull-gear is 71 ft. 6½ in. There are two platforms, both clearly visible in the illustration, and a built-in. steel ladder for access to the nacelle. The cables carrying the generator output to the transformer can be seen running down the leg of the tower nearest to the control room.

NACELLE : FIXED AND FLOATING BEDPLATES

The nacelle and its mounting are shown in section in Fig. 2. It is mounted on a pintle shaft to allow the windmill to be yawed round to suit the direction of the wind. The windmill head is supported by the bull-gear, a large and heavy steel casting fixed to the seating on the top of the tower. The bull-gear casting forms the housing for the bearings in which the pintle shaft and hence the whole windmill head rotates. The pintle shaft itself is a hollow steel casting 4 ft. long, 13½ in. outside diameter at the centre and tapering towards each end, with a wall thickness of 1 in. To the pintle shaft the fixed bedplate is rigidly attached.

The fixed bedplate is a welded steel framework 18 ft. 5 in. long by 4 ft. wide. At the windward end are containers for ballast weights, which help to relieve the bending stress in the pintle shaft; this bending stress is also relieved by four sets of rollers running on the flange of the bull-gear, one of which can be seen in Fig. 2 at the forward end of the bull-gear. At the centre of the fixed bedplate are the bearing housings for the journals of the floating bedplate (the bearing housing is shown in Fig. 2 as " rocking centre of floating bedplate ").

The floating bedplate is also a welded steel framework, and supports the hub and blades, gearbox, and generator. The whole floating bedplate can move in a vertical plane about the rocking centre, but its movement is restrained by the main springs, auxiliary coil springs and auxiliary transverse spring. The effect of this mounting is to reduce the transmission of vibration and shock from the rotor to the pintle shaft and tower; the combination of springs cushions any relative movement there may be between the fixed and floating bedplates.

In Fig. 6 the hub and gearbox are shown being lifted into position during the construction of the windmill. The bottom half of the nacelle is in position, and the top half can be seen lying on the ground in front of the tower. Erection could only be carried out while the wind allowed, and raising the heavier items was the most difficult part of the job.

LIGHT WOODEN BLADES

The propeller hub consists of a central boss to which are welded three short hollow flanged arms, to each of which is bolted a tubular extension piece. From the centre of the boss to the fixing point for each blade is 8 ft., and with blades 17 ft. long this gives a swept circle of 50 ft. diameter. The blade spars are made of compressed laminated wood, the ribs of spruce, and the skin of ⅛-in. mahogany ply covered with plastic coating and painted; the weight of each blade is about 150 lb. At the point of attachment to the hub is a high-tensile steel fitting. Each blade fitting is attached by quickly detachable fork joints with taper-pins to a universal joint with needle-roller bearings. These give the blades freedom to " cone " and " drag " when up to speed (" dragging " is the movement of the blades about their root fittings in the plane of rotation, and " coning " is the movement of the blades about their root fittings towards and away from the tower).

The point of attachment is shown in Fig. 3, which also shows the damping gear which operates in the drag plane. The coupling through the two universal joints and the shaft at the bottom left of Fig. 3 gives the blade freedom to draw out and to move in the coning plane, but movement in the drag plane is controlled by the damper. The blade itself acts as a damper in the coning plane. When the machine is shut down, draw-out springs pull back the root fittings about 2 in., thereby causing a shaped part of the universal joint shank to seat on a hollow rubber cuff in the end of the hub arm, thus restraining the universal joints and holding the blade steady. Because the blades are held in this fixed position by springs and because the seating is rubber, there is a certain amount of freedom to move if the winds are very strong. In the winds at Costa Head this provision has been of great value.

The drive from the hub is transmitted through a step-up gearbox, weighing 2 tons, which operates with an input speed of 130 and an

Fig. 1 The 100-kW generator on Costa Head consists basically of a triangular-section steel tower, a control room at the base of the tower, and a nacelle containing the step-up gearbox and generator. The generator output is transformed to 11 kV and fed into the Orkney mainland distribution network through the overhead line.

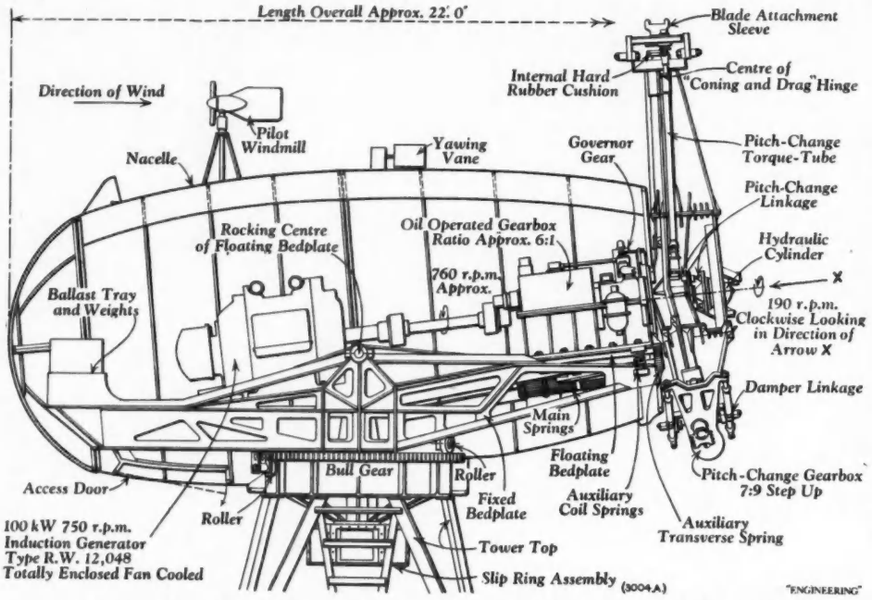


Fig. 2 Sectional elevation of the nacelle; the gearbox contains the hydraulically-operated brake and clutch. Power from the generator is fed through slip-rings, which allow the nacelle freedom to yaw, and down cables to the transformer at the foot of the tower.

output speed of 750 r.p.m. The gearbox also contains a brake and a clutch, both hydraulically operated. The output shaft of the gearbox drives the induction generator. The generator was made by Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, who also made the electrical control gear. The generator is of the slip-ring type, is totally enclosed and fan cooled, and its output is 100 kW at 415 volts, 3 phase, 50 cycles; it weighs about 2 tons.

CONTROL OF ROTOR SPEED

The control mechanism of the Costa Head generator holds the rotor speed nearly constant while the machine is generating. In addition, the control mechanism starts the machine when the wind speed becomes sufficiently high, stops the machine when the wind speed becomes too low, and also stops it in emergencies. The sequence of starting is first described in general terms, and is followed by a more detailed account of the control mechanism.

With the clutch disengaged the generator is run up to speed as an induction motor; this also starts the oil pumps for main lubrication and the various hydraulically-controlled systems. A brake on the rotor is released and the pitch-change mechanism gradually alters the pitch of the blades from full feather to fine pitch, thus enabling the wind to start up the rotor. The rotor gathers speed at a pre-determined rate under the control of the governor, and when the speeds of the rotor and generator are correctly matched the clutch is engaged to connect them mechanically. The electrical control gear then measures the electrical output and cuts out resistance in the generator rotor circuit and adjusts the governor so that the machine is made to carry full load.

Under working conditions this operation is automatic, controlled by the electrical gear in the building shown at the foot of the tower in Fig. 1. If necessary, however, the operation can be done manually through a series of press-buttons associated with coloured signal lights which indicate how far the starting procedure has progressed. The shut-down sequence is normally automatic. Safety devices ensure that in the event of an electrical failure or any other mishap the windmill is brought to rest and prevented from re-starting until the fault has been rectified.

When the plant is operating automatically indication of the wind-speed is given to the control gear from the pilot windmill shown on top of the nacelle in Fig. 2. The pilot windmill drives a tacho-generator the output voltage of which is proportional to the wind-speed over the appropriate range. When the wind speed rises above 23 m.p.h. the tacho-generator voltage becomes sufficient to close an instantaneous relay. Since the wind may reach 23 m.p.h. in a gust and then die away again the instantaneous relay is connected to an integrating relay, which can integrate the wind speed over varying periods up to a maximum of 10 minutes. If the wind remains strong enough for the required period supply to the generator is switched on, and it runs up to full speed as an induction motor. At this stage all the resistance in the generator rotor circuit is in, and the clutch in the gearbox is disconnected.

ELECTRIC AND HYDRAULIC CONTROL GEAR

As soon as the generator is running the pumps, which are mechanically connected to the generator, begin to deliver oil. The low-pressure pump (which is not shown in Fig. 4) supplies oil at 60 lb. per square inch, which releases the brake in the gearbox, setting the blades free to rotate. The high pressure pump supplies oil to the 2½-gallon capacity accumulator (shown in Fig. 4), gradually increasing the pressure to 500 lb. per square inch. When the accumulator pressure reaches a pre-set value (about 400 lb. per square inch) a pressure-switch closes and allows the starting sequence to continue.

During this time the governor speed-setting lever, which bears on the speeder spring, has been brought to its lower position by the actuator. The actuator is basically a small electric motor, and the impulses that operate it are entirely electrical. When it is at its lower position it operates a switch which causes the solenoid connected to the governor emergency valve (both shown in Fig. 4) to be energised, and this gives control of the blades to the governor working through the main governor valve, shown just above the emergency valve in Fig. 4.

The lowest speed setting of the governor is about 40 r.p.m. and the blades now move towards fine pitch under the control of the governor, speeding up under the influence of the wind until they reach this set speed. When they do so a switch on the governor is closed and the actuator starts to move the speed-setting lever slowly upwards; once the switch is closed the actuator moves independently of anything else. The speed of the blades now increases under the control of the governor until it reaches the highest speed permitted by the governor, about 10 per cent. above normal running speed.

RUNNING UP AND CONTROLLING GENERATOR OUTPUT

When the blades are running at the highest permitted speed a switch on the governor closes, causing the clutch in the gearbox to be engaged. The set now starts to generate, but the output will not be large since all the resistance is still in the rotor circuit. A power relay now operates the actuator to reduce the generator speed and so reduce the generated power. When the power lies between 0 and 5 kW one resistance bank is removed from the rotor circuit. The generated power therefore increases, and the power relay again reduces the speed until the power lies between 0 and 5 kW and then cuts out a further stage of rotor resistance. This process continues until the rotor resistance is reduced to the required value.

Control of the actuator now passes from the power relay to a current relay which endeavours to increase the speed until the power output is 100 kW. This will only be possible if the wind is over 35 m.p.h.; if it is not, the blades will go to the fully-fine position and the windmill output will depend upon the wind speed.

If the wind is over 35 m.p.h. normal governing will take place. Suppose that the speed of the blades rises above the set speed of the governor. The governor fly-weights will move outwards compressing the speeder-spring, and lifting the governor pilot-valve. The governor servo-piston will follow the movement of the pilot valve and will open the main governor valve, the connecting link pivoting about the end of the feed-back dashpot. The blades will now tend to seek coarse pitch and as they do so the pitch-change cylinder (the Rotol cylinder in Fig. 4) will operate the rack and pinion gearing of the feed-back motion (shown as "return-motion linkage" in Fig. 4), compressing the centring spring and re-closing the governor valve. The blades now slow down so approaching the set speed and the governor pilot-valve will tend to reset followed up by the governor servo-piston. At the same time the feed-back dashpot will reset under the pressure of the centring spring. Ideally the dashpot rate will correspond to the re-setting rate of the governor pilot-valve so that the lever pivots about the governor valve fulcrum. A given movement of the governor pilot-valve thus causes a proportional movement of the

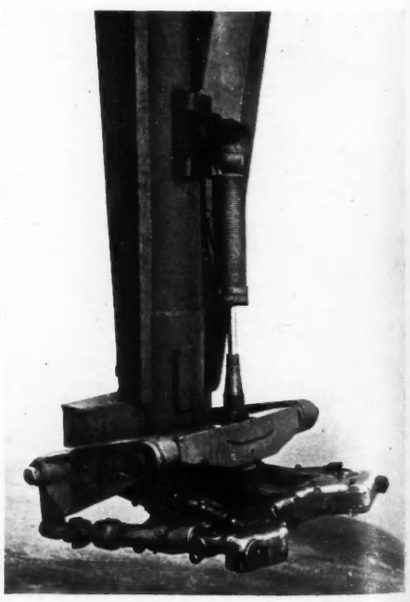


Fig. 3 The damper gear which is mounted on each of the three arms of the hub controls blade movement in the drag plane; the blades themselves act as dampers in the coning plane.

blades, tending to prevent departures from the set speed. The dashpot in the return-motion ensures that the set speed is always in the centre of the range of the pilot-valve travel.

While the governor maintains the windmill speed at its set value the current relay continually causes the actuator to make small adjustments to this set speed in order to maintain the output at 100 kW despite changes of line frequency. The total effect is that normal control of speed is by the governor fly-weights; the actuator, operating through the speeder-spring and subsequent linkage, acts as an over-riding control to make the necessary adjustments for changes of line frequency. A view of the governor and the inboard part of the hub is shown in Fig. 5. One of the torque-tubes which change the blade pitch can be seen extending upwards and to the left at the far end of the control gear.

SHUTTING THE WINDMILL DOWN

If the speed of the wind rises above a pre-set value (about 60 m.p.h.) and remains above that value, the pilot windmill operates a relay which de-energises the master contactor taking the generator off the line. The speed setting is now reduced to 30 per cent. full speed and the windmill will slow down. At its bottom limit the actuator operates a switch which de-energises the solenoid holding open the emergency valve. The same procedure is followed if the wind falls permanently below the lowest setting (about 23 m.p.h.). The clutch in the gearbox remains engaged.

When the solenoid of the emergency valve is de-energised the valve is closed by a spring. The governor then has no control over the blades, which move gradually to their fully-coarse position, thus stopping the windmill. Oil pressure is meanwhile maintained by the oil accumulator, backed up by the pumps, since the generator continues to be driven by the blades. When the blades come to rest oil pressure is lost and the brake in the gearbox engages, holding the blades against rotation.

In an emergency shut-down the solenoid holding open the emergency valve will be immediately de-energised by operation of an emergency relay or by line failure, and will thus allow the set to be shut down fairly rapidly. If the shut-down was due to an emergency condition the machine cannot be started again until the emergency relay has been re-set by hand. Otherwise the machine will start again as soon as conditions are suitable.

Yawing of the nacelle is controlled by a vane on top of the nacelle. This was originally a separate vane but is now combined with the pilot windmill. As the wind blows the vane away from the centre-line of the nacelle an electric contact is made which drives the yawing motor in the appropriate direction. The motor is a 1-h.p. electric motor which drives a pinion which engages with the bull-gear. The drive is transmitted from the motor to the pinion through a 400 : 1 speed reducing gearbox. Between the gearbox and the pinion there is a slipping coupling which allows the nacelle to rotate if struck by a sudden exceptionally strong gust of wind from an unexpected quarter.

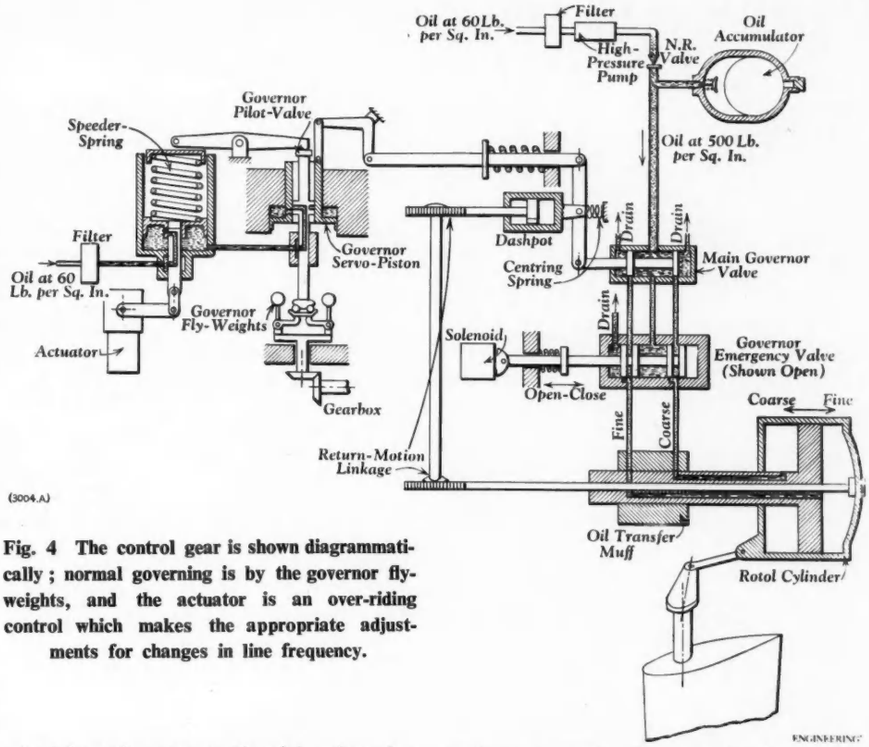


Fig. 4 The control gear is shown diagrammatically; normal governing is by the governor fly-weights, and the actuator is an over-riding control which makes the appropriate adjustments for changes in line frequency.

Some of the problems of using wind-power have been discussed in ENGINEERING previously, particularly in an article on Enfield Cables' experimental machine near St. Albans (March 25, 1955, vol. 179, page 374), and in the report on Mr. E. W. Golding's paper before the Institution of Electrical Engineers on March 31, 1955 (ENGINEERING, April 8, 1955, vol. 179, page 433). The main problem is essentially that the wind is a reliable source of energy but an unreliable source of power, and if wind machines are to be used to the best advantage they must incorporate some method of storage.

Wind machines must first be a sound practical installation, and it is not until they have worked on an operational site that they may be said to have proved themselves fully. John Brown and Company have learnt much from their machine on Costa Head, and while this machine will continue to supply useful amounts of energy to the network on the Orkney mainland, they are developing a new and larger wind-driven machine on slightly different lines.

The new machine will be of 250-kW capacity, and its design has been guided by experience gained in construction of the Orkney windmill. Many of the components found redundant at Costa Head will be eliminated in the projected model, thus simplifying construction. The most important change is that it will have only two blades rigidly mounted on a rocking yoke to allow them relief when struck by a gust of wind. Development of this model is proceeding, and it is hoped that operational sites will be found both in this country and overseas.

Fig. 5 The governor and inboard parts of the hub shown from inside the nacelle; one of the torque tubes which adjust blade pitch can be seen at the far end of the governor mechanism going off upwards and to the left.

Fig. 6 A stage during construction, showing the hub and gearbox being lifted into position in the nacelle. The top half of the nacelle can be seen lying on the ground at the foot of the tower.

DISPOSAL OF TOXIC EFFLUENTS

HANDLING ACIDS AND CYANIDES

The toxic nature of cyanides is well known, but the essential part played by them in the engineering industry is probably not fully appreciated. Cyanides and other toxic chemicals such as chromic acid and the more common acids are in everyday use in the plating and hardening shops, where their dangerous nature has been understood and the appropriate safeguards in handling them have been taken. These materials, however, when they have ceased to be of any use due to contamination and to the chemical reactions which have taken place during the processes, still retain their toxic nature, and must be treated to make them harmless. Also during swilling operations a proportion of these chemicals run to waste and have to be rendered harmless. Until the last few years it was not realised that even very low concentrations of cyanide were harmful and, as these almost always reach rivers, special precautions are now having to be taken in the discharge of these wastes into town sewers. Where the effluents are discharged direct into rivers the precautions must be still more rigid.

The fact that approximately 50 per cent. of England's drinking water is drawn from rivers emphasises the importance which is now attached to effluent disposal. Aquatic life including fishes is affected by even lower concentrations of these toxic materials than are human beings. Some of the problems of water pollution were discussed in an article on the new buildings of the Water Pollution Research Laboratory published in ENGINEERING for July 1, 1955 (vol. 180, page 14). In that article reference was made to various processes both operational and experimental for the disposal of cyanide-contaminated effluent.

Following successful experiments with a new method of effluent disposal which were carried out in their old plant at Rugby, the British Thomson-Houston Company, Limited, have recently constructed a new continuous-flow plant to neutralise toxic effluents from their plating and pickling shop.

The principal constituents of the effluent are swill waters from running rinse tanks following sulphuric, hydrochloric and nitric acid picklings, chromic acid passivation and cyanide cleaning or plating tanks. The layout of the drains in the plating shop is such that these different groups cannot be kept to separate parts of the shop, and the swill waters carried to separate drains. Consequently, while precautions can be taken to ensure that spent acids and cyanides in static tanks are dealt with under arrangements to be described later, the swill waters from running rinse tanks, whose maximum rate of flow is approximately 16,000 gallons per hour, are all sent down a common drain to the effluent disposal plant.

Two important factors should be mentioned at this stage. The first is that due to the configuration of the ground, the flow throughout is by gravity; and secondly, since the effluent after treatment is put direct into the River Avon near its source, and not into the Corporation's sewers, very much stricter conditions are laid down by the Severn River Board regarding what may be discharged. Thus, the cyanide (HCN) content must not exceed 0·1 parts per million.

MIXING ROOM AND VATS

The new plant consists of four large vats surrounded by handrails, each measuring 50 ft. long by 6 ft. 8 in. deep, but of different widths, through which the effluent flows. Two factors which affected the design of the vats were the need to provide large areas for trapping the suspended and precipitated solids and the need of a large volume of water to smooth out the rapid fluctuations in acid, alkali and cyanide content. Further, in the event of any violent fluctuation in acid or alkali content, approximately four hours would elapse between its being detected and its beginning to flow out of the last vat, thus allowing ample time for any special corrective measures. Beside the vats is a building containing a chemical store, a mixing room and a small laboratory for sample testing.

In the mixing room are located two tanks and a chemical feeder. The first tank is 6 ft. in diameter by 5 ft. high, and is shown with the feeder in Fig. 1. It has a capacity of 700 gallons and it is equipped with a high-speed mixing impeller driven by a 1-h.p. compressed-air motor. In this tank a 3 per cent. (by weight) mixture of hydrated lime and water is prepared and held in suspension. This milk of lime is used for neutralising the acids in the effluent, and is fed by means of the chemical feeder, also driven by an air motor, through a special valve into the incoming effluent channel. At present this valve is controlled by hand, but automatic equipment is being installed which will control it proportionally to both the pH value of the effluent and its rate of flow, and will also record the pH value of the effluent on entering and leaving the plant.

The second tank is 4 ft. 6 in. in diameter by 4 ft. 6 in. high and has a capacity of approximately 450 gallons. In this tank a 1 per cent. solution of potassium permanganate in water is prepared. This is used for oxidising the cyanides in the effluent at a later stage, the potassium permanganate being taken through a ¾-in. diameter pipe to the point of admission. Exhaust air from both motors is used to provide agitation in the first vat, this being supplemented by air in a second pipe system from the works mains.

OPERATION OF THE CONTINUOUS FLOW PLANT

As the effluent enters the plant, any oil, grease or scum is held by means of an oil trap, which is cleaned out daily. In the first stage of treatment the acids in the swill waters are neutralised with lime. As already mentioned the milk of lime is pumped into the incoming effluent channel by means of a chemical feeder through a regulating valve. The milk of lime and effluent are mixed in the tail race of a weir, and immediately below this point in the channel the pH electrode is installed. At this point the pH value of the effluent is kept as near as possible to 7·0, which is the neutral position between acid and alkali. Close control is of particular importance, as the potassium permanganate oxidises the cyanides more effectively with the pH value between 6 and 8.

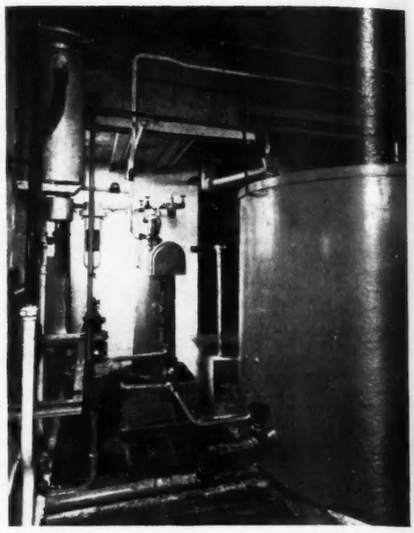


Fig. 1 The tank on the right of the illustration has a capacity of 700 gals., and in it is mixed a 3 per cent. solution of hydrated lime. This is fed through the chemical feeder into the effluent channel to neutralise acids.

AGITATION BY COMPRESSED AIR

After preliminary mixing with milk of lime in the inflowing channel, with brick baffles to cause a swirling action, the effluent passes into the vats. The first vat, of approximately 22,500 gallons capacity, is 12 ft. wide and is sub-divided by three cross walls to give an under-over-under flow, the effluent being agitated by means of compressed air during its whole journey through this vat (see Fig. 2). The air pipes near the bottom of the vat are designed not only to give violent agitation of the contents by means of several large ports, but also to give a rising curtain of tiny bubbles from many small holes. This agitation has the effect of preventing any settlement of suspended or precipitated solids and also ensures thorough mixing. The oxygen in the air also helps to oxidise any ferrous salts. By the time the effluent leaves this vat the acids have been completely neutralised.

The second and third vats are of approximately 37,000 gallons capacity each and are 19 ft. 8 in. wide. They are both sub-divided by two honeycomb cross walls, and are not normally agitated. Air agitation pipes are, however, installed to enable the suspended solids to be agitated when potassium permanganate is added to the sludge before disposal, as mentioned below. Here the settlement of the suspended solids takes place. These consist of iron hydroxide, calcium sulphate and calcium hydroxide and some copper hydroxide and sodium ferrocyanide. It was expected that the settlement would take place to a large extent in the first of these vats only, and this has been borne out in practice. Consequently when one vat is practically silted up it is by-passed and emptied after treatment with potassium permanganate to oxidise any cyanides in solution, while the other vat only is being used for settling. Cast iron sluice gates sealed with clay are used to divert the flow as required throughout the whole plant, and some of these can be seen in Fig. 2.

The fourth vat is sub-divided in the same manner as the first, and is the same size. Here oxidation of cyanides takes place by the addition

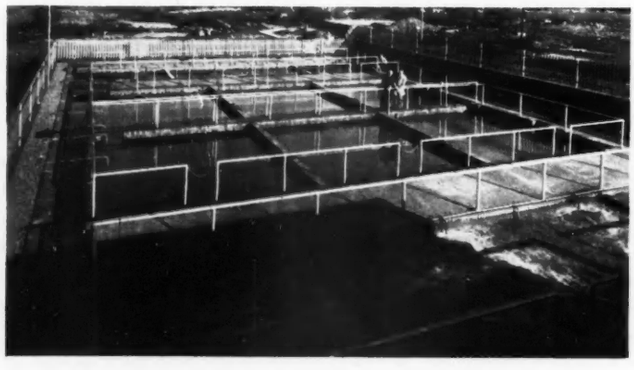


Fig. 2 A general view of the four large vats. In the vat at the bottom of the illustration the effluent is being agitated by compressed air. In the second and third vats the suspended solids settle, and in the fourth the cyanides are oxidised by potassium permanganate.

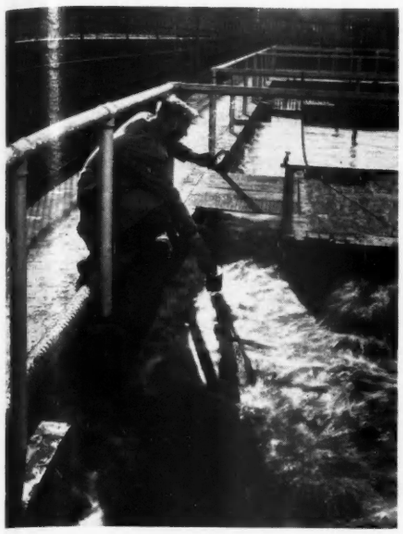


Fig. 3 A laboratory assistant checks the rate of flow of potassium permanganate into the fourth vat, where the cyanides are oxidised. A tracer steam pipe beside the permanganate pipe prevents freezing in winter.

of potassium permanganate. At the point of entry of the effluent, a 1 per cent. solution of potassium permanganate is allowed to trickle in. The rate of flow is 1 litre per minute during the day and 1 litre in 1½ minutes during the night and at weekends, when the rate of flow of the effluent is lower and the cyanide content is less. If the plating shop is shut down during a weekend or a holiday period, the potassium permanganate is left to flow at 1 litre per 1½ minutes for a further 24 hours. The rate of flow is checked by means of a graduated glass and stop clock, and Fig. 3 shows a laboratory assistant checking this flow.

Air agitation in the fourth vat is employed in the first section only, the remaining three being used as settling tanks for the precipitation of manganese hydroxide. On leaving the last vat of the plant the cyanide content has been reduced from an average of 3 parts per million on entering to an average of 0·4 part per million.

After leaving the plant, the effluent flows through marshland of approximately 2½ acres area where the excess potassium permanganate is precipitated by the organic matter. It is thought that the residual cyanides hydrolise during their passage through the marshland, varying between 6 and 48 hours, and the cyanide is further reduced from 0·4 part per million to 0·05 part per million except in very cold weather.

From this marsh land the effluent filters through a bank of clinker into hollow breeze blocks, which form a collecting drain. This joins a cooling water drain from the factory and the effluent is further diluted, so that by the time the effluent passes off the property it is averaging only 0·03 parts per million of cyanide.

BATCH TREATMENT

So far only the treatment of swill waters has been dealt with, although reference was made above to spent acids and cyanides. From time to time it is found necessary to empty tanks containing these, and the procedure varies according to the contents.

Spent sulphuric, hydrochloric and nitric acids are syphoned at a controlled rate not exceeding 200 gallons per hour into the effluent drain, and they are treated at the effluent plant by the method already described, except that the milk of lime is increased as required.

Chromic acid is treated separately by reducing the hexavalent chromium to the trivalent condition with a 30 per cent. solution of ferrous sulphate, and then precipitating the chromium hydroxide and ferrous hydroxide by the addition of hydrated lime. When analysis shows this reaction to be completed the slurry is diluted and syphoned into the effluent drain at a controlled rate not exceeding 60 gallons per hour.

Cyanides from static swill tanks are reduced by the addition of a 30 per cent. solution of hot ferrous sulphate. This has the effect of reducing the cyanide content from approximately 20,000 parts per million to approximately 100 parts per million. Excess ferrous sulphate is precipitated with hydrated lime and the liquid is then syphoned into the effluent drain at a rate not exceeding 30 gallons per hour. Further reduction takes place during the normal treatment in the effluent plant, where the potassium permanganate flow is stepped up to 2 litres per minute while the stronger cyanide solution is passing through.

At present both chromic acid and cyanides receive the above treatments in their own tanks in the plating shop, but a further development is in hand whereby this treatment will in future be done in additional vats adjacent to the effluent plant. When this plant is ready, chromic acids or cyanides for treatment will be pumped into special steel containers which will transfer them from the plating shop to the effluent plant,

The possibility of a sudden flood of acid or cyanide due to a burst tank in the plating shop has been considered. It is thought that the hydrochloric, sulphuric and nitric acids could be taken care of by the effluent plant, as none of these tanks is large, but the dangers which would arise in the event of a burst chromic acid or cyanide tank are considerable. These tanks will therefore be put in outer jackets which will normally be empty, but which will retain the liquid in the event of a leak or burst. Where any of these tanks are heated by means of a steam coil, they are being changed over to electric heating to prevent the possibility of a leaking steam coil resulting in an overflow.

As will have been seen from the figures given, very good results are being obtained from the new plant using hand control, and it is thought that once the automatic control and the other proposals outlined above are in operation, even better results will be obtained.

OIL-BURNING LOCOMOTIVES FOR THE SUDAN

Forty-two locomotives now under construction at the Hydepark Works of North British Locomotive Company, Limited, Glasgow, for the Sudan Railways are of the 4-8-2 type with oil-burning apparatus. They are for 3 ft. 6 in. gauge and have double four-wheel bogie tenders.

The locomotives were designed to the requirements of the Chief Mechanical Engineer, Sudan Railways, and constructed under the supervision of the London office of the Sudan Government.

The boiler barrel consists of two rings, the outside diameters at front and rear being 6 ft. 0⅝ in. and 6 ft. 2 in. respectively. The distance between the tubeplates is 17 ft. 6 in. and there are 32 superheater flue tubes and 122 boiler tubes of 5½ in. and 2¼ in. outside diameter respectively. Laidlaw, Drew oil-burning equipment is provided and includes a burner, a strainer, and a heating coil in the oil-fuel tank. Tubes are fitted in the firepan bottom plate in such a manner as to provide a clockwise air flow.

A Melesco superheater is fitted and the header incorporates a multi-valve regulator. Three Gresham and Craven R.C.W.-type live-steam injectors are provided.

The main frames are machined from "Coltuf 28" steel plates 1¼ in. thick and stayed. Axle-box horn guides of cast steel are fitted with steel shoes to which manganese-steel liners are attached. The coupled axleboxes are steel castings with gunmetal bushes and cast-iron keeps, and are provided with guide liners of manganese steel.

Laminated bearing springs are applied under all coupled wheels, with adjustable spring links, and compensation is arranged between the trailing coupled and hind-truck wheels only.

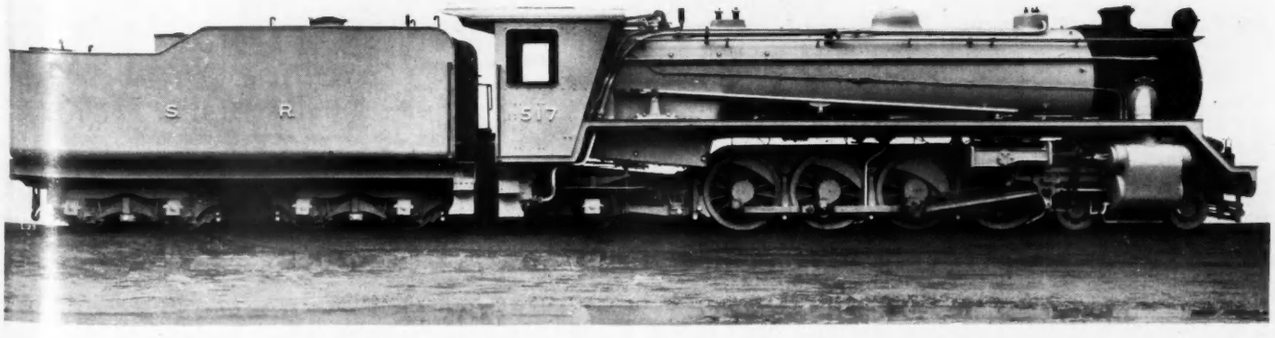
Steam distribution is effected by 11 in. diameter piston valves actuated by Walschaerts valve gear. Laird-type crossheads are fitted.

The four-wheel front bogie has plate frames, laminated bearing springs applied over each wheel and adjustable spring links. Side control is by means of coil springs placed forward and backwards of the bogie centre. Axleboxes are steel castings fitted with gunmetal bushes. The two-wheel hind truck is of the radial-arm type.

The tender carries 6,250 gallons of water and 7 tons (1,700 gallons) of oil fuel.

The following are the main dimensions, etc.:—

Cylinders, dia. and stroke	21½ in. by 26 in.
Wheels, coupled, dia.	4 ft. 6 in.
Wheelbase, coupled	14 ft. 9 in.
Wheelbase, engine	33 ft. 0 in.
Wheelbase, engine and tender	61 ft. 10 in.
Height, rail level to top of chimney	13 ft. 0 in.
Heating Surfaces:—	
Large tubes	769 sq. ft.
Small tubes	1,258 ,, ,,
Firebox	203 ,, ,,
Total Evaporative	2,230 ,, ,,
Superheater	542 ,, ,,
Total	2,772 ,, ,,
Grate Area	40 ,, ,,
Boiler pressure	190 lb. per sq. in.
Tractive effort (85 per cent. B.P.)	35,940 lb.
Weight in working order:—	
Engine	87·05 tons.
Tender	60·9 ,,



One of the 42 oil-burning locomotives which North British Locomotive Co., Ltd., are building for the Sudan Railways.

AUTOMATIC MOULDING MACHINE

PLANT FOR THE FULLY MECHANISED FOUNDRY

One of the latest moulding machines to be put on the market is that which is now being made by the Coleman-Wallwork Company, Limited, 32 Victoria-street, London, S.W.1. Demonstrations of it were given recently at their works at Stotfold; it is entirely automatic in operation and can therefore be incorporated in high-flow mass production lines. The standard size for each half box is 34 in. by 20 in. by 10 in. deep, and these can be handled at rates up to 240 per hour. All operations are controlled by electronic timers which can be adjusted to suit the particular needs of the pattern being used. The operations can be manually controlled if desired.

The machine as set up in the maker's works is shown in Fig. 1 and a diagrammatic layout of a complete installation is given in Fig. 2. When set up on site, the sand delivery equipment is mounted above for filling the mould boxes, as in Fig. 2. Boxes for filling arrive by conveyor at the extreme left and pass into the machine till they reach a stop, breaking a light beam as they do so. The box containing the light cell which receives the beam can be seen in Fig. 3, mounted on the central upright of the frame. Lifting gear, which is mounted below a trolley, then lifts the empty box by means of pneumatically-operated pawls and the trolley takes the box to the next station (immediately behind the control panel in Fig. 3). Here a pneumatic cylinder (which can be seen on the left in Fig. 1) pushes the box against a stop which acts as a locator for subsequent operations. The box is again lifted and carried by the trolley to the third station, the platform of the jolting mechanism.

TRANSFER TROLLEY

In addition to the lifting gear already mentioned, the trolley carries a sand chute, and a presser-head for squeezing the sand down. Its functions are, therefore, to pick up and move the box from the incoming conveyor to the alignment station; to move it from there to the moulding station; to guide the sand into the box; to press down the sand into the box and to eject the finished mould. All these operations are carried out by pneumatic power, smoothness being ensured by using an air-on-oil pusher cylinder.

At the third station, where the actual moulding is carried out, as soon as the empty box has arrived the stripping frame is lowered and the moulding box located on the pattern pins. A short jolt then settles the box firmly on the pins. Next a weighed amount of sand is fed into the box through the chute on the trolley (the sand feeding equipment will be described later), and the machine jolts the box freely. The presser head is then moved into position and the machine jolt-squeezes for the chosen period, after which the head is lifted. When a cope (the upper half of a mould) is being moulded runner cups are attached to the head and move with it. Vibration is applied to the pattern, it is stripped from the mould and the finished mould transferred to the last station of the machine; at the extreme right in Fig. 1 the pattern plate is then sprayed with a parting fluid ready for the next mould.

FULLY-MECHANISED INSTALLATION

The makers suggest that for a fully mechanised foundry two of these machines should be used, one for making the cope and the other for the drag (the lower half of a mould), arranged in conjunction with a pallet-type mould conveyor in the matter of the diagram, Fig. 4. In this installation, the pairs of boxes would proceed from the knock-out point, and the cope be lifted off for feeding into the machine at A, and the drag at B. Between the last station of the drag machine and the pallet conveyor the drag must be inverted. For this a turnover unit has been designed which receives the mould from the machine. Here the edges of the box are resting on edge rollers which are attached to a pneumatic cylinder. Air is exhausted and the rollers lowered, leaving the box suspended by a trunnion at each side. These trunnions are then rotated by a rack and pinion mechanism so that the box is reversed, and the edge rollers are again lifted to take the weight. The drag is then transferred to the pallet conveyor at point C. Cores would be added if required and the cope placed in position at point D.

The transfer unit, which is similar in both cope- and drag-making machines, consists of a lifting mechanism mounted on a trolley, both being pneumatically operated. On the arrival of a mould, the lifting arms engage the box and the trolley moves it over the pallet conveyor.

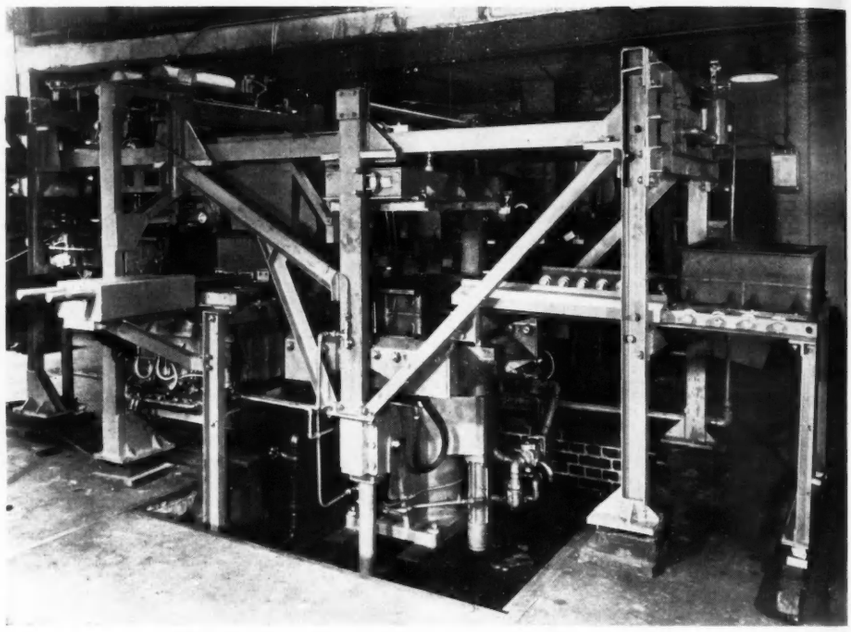


Fig. 1 This moulding machine can produce 240 half moulds per hour. It is shown here set up in the maker's works without sand delivery equipment.

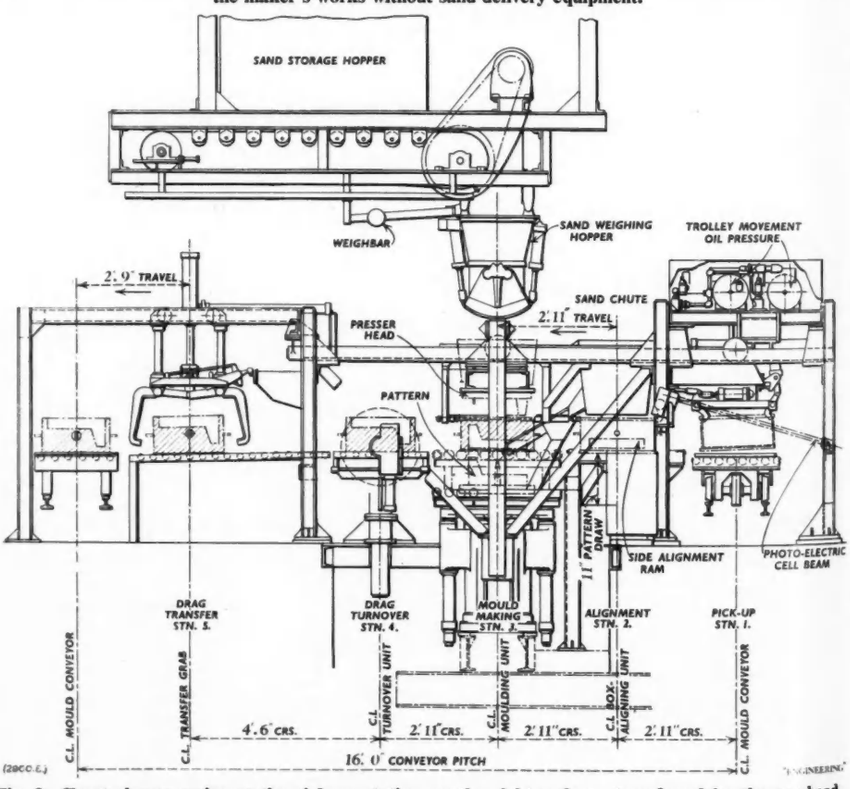


Fig. 2 Empty boxes arrive at the pick-up station on the right and are transferred by the overhead trolley to the different stations. The turn-over mechanism is only required when lower halves, or drags, are being made.

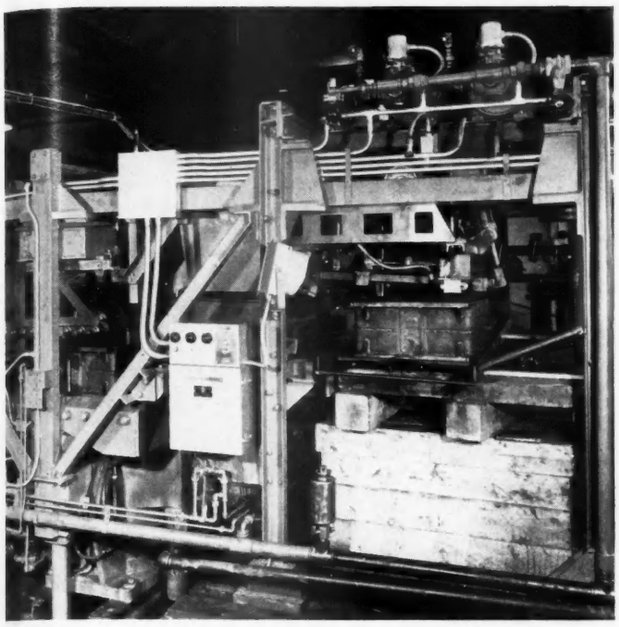


Fig. 3 The arrival of an empty box breaks a light beam and initiates the cycle of operations.

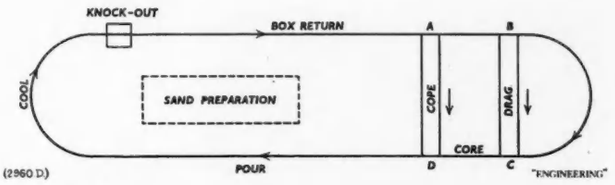


Fig. 4 (above) For a mechanised foundry layout, two machines are used, one for making the copes and the other the drags. Cores are inserted by hand between points C and D on the diagram.

A locating device on the latter causes the box to be lowered on to the centre of a pallet of the conveyor, after which the trolley returns to its "ready" position for the next box. These operations are also automatic so that the only manual work involved in the whole process is the fitting of the cores into place. The amount of this varies, of course, with the complexity of the pattern.

WEIGHED SAND SUPPLY

The general arrangement of the sand delivery equipment can be seen by reference to Fig. 2. A main storage hopper feeds on to a moving belt which supplies the sand to the weighing hopper. The weight for each fill can be adjusted by the movable runner on the weighbar to suit the particular mould being made. A wide range of weights is available. When the weighbar lifts, the drive to the conveyor is stopped so that no more sand is fed into the hopper. At the correct moment in the cycle, the hopper doors are swung open by the pneumatic cylinders, allowing the sand to fall through the chute on the trolley into the mould. The doors then close and the weighing hopper is refilled. It is possible of course to place the storage hopper at any convenient point; it is only shown in the diagram as being directly above the machine for clarity.

The panel from which all the machine operations are controlled can be seen in Fig. 3. The upper portion houses the automatic controls and the lower the setting resistances for timing the operations and the push buttons for manual operation. A separate unit houses the relays and electronic equipment. The timing unit operates the solenoid-operated valves which control the pneumatic cylinders of the machine, the whole cycle being initiated when the light beam is broken by the arrival of an empty box. Air at 85 lb. per square inch is required to operate the standard machine.

As stated earlier, the nominal box size for the machine is 34 in. by 20 in. by 10 in. deep, and these can be handled at the rate of 240 per hour. The maximum useful load which can be dealt with is 1,000 lb. and the maximum pattern draw 12 in. The squeeze pressure which can be exerted is 17,000 lb. Air consumption at 85 lb. per square inch is approximately 200 cub. ft. per hour.

GRINDING TOOLS AND CUTTERS

MACHINE WITH THREE OPERATING POSITIONS

The No. 1 cutter and tool grinding machine introduced by Cincinnati Milling Machines Limited, Woodlands Farm-road, Birmingham, 24, is similar to, but smaller than, their No. 2 machine, and incorporates some new features. It has a capacity up to 8 in. diameter and 15 in. between centres; the length between the tailstock and the workhead which is provided for grinding tools with taper shanks is 11½ in. The machine is T-shaped in plan, and can be operated from any one of three points, giving the operator the best view of the work and the most comfortable working position according to the type of tool being ground. Controls are either accessible from all three working positions, or are duplicated where necessary.

ECCENTRIC-MOUNTED WHEELHEAD

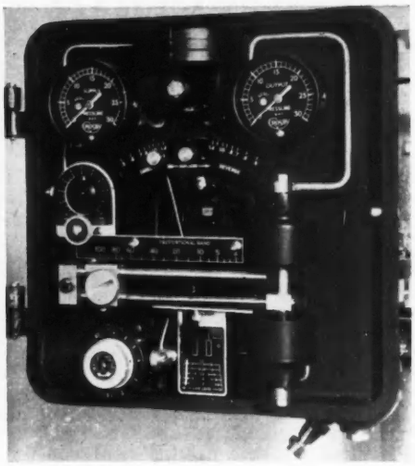
The grinding-wheel spindle is of the cartridge type, mounted in pre-loaded ball bearings, and grease-packed to obviate the need for external lubrication. A reversible, integrally-mounted electric motor of ½ h.p., controlled by push-buttons from a panel at the front of the machine, drives the spindle through two-step pulleys and a tooth-grip belt. This arrangement gives surface speeds of 5,860 ft. per minute on a 6-in. diameter wheel, and 5,740 ft. per minute on a 3½-in. wheel. The wheelhead is carried on a column which can be raised and lowered over a total distance of 7 in., and is capable of being swivelled through 360 deg. The mounting of the wheelhead is eccentric to the column, and the swivelling movement locates the wheel in the position required with a minimum of overhang. The column elevating screw and nut are lubricated by an oil bath inside the column, which is provided with a concertina-type seal to prevent the entry of dust. Height adjustment is by means of a handwheel at the top of the column, accessible from all the working positions. For cross-adjustment there are duplicated handwheels, at the front and rear of the machine, the total head movement being 4½ in.; the effective range, as a result of the wheelhead eccentricity, is 7½ in.

SWIVEL TABLE FOR TAPER GRINDING

The main table runs on two rows of steel balls, with hardened and ground replaceable anti-friction ways, and is traversed by rack and pinion with duplicated handwheels. Curtain-type dust guards are fitted to protect the table ways. Spring-cushioned, adjustable stops are fitted at the front of the table, and these can be reversed and used as dead stops with fine adjustment when required. Mounted on the main table is a swivelling work-table, with a working surface of 4 in. by 24 in., and a slot for attaching tailstocks or workhead. The work-table is offset from the main table, and can be turned through 180 deg. to obtain more space for grinding long cutters. It is fitted with a quick-setting device for taper grinding, based on the trigonometrical function of the tangent of the angle. Gauge points are provided at the end of the table, and the operator uses standard gauge blocks for setting purposes.

Two tailstocks are provided, the right-hand one having a retractable centre which is adjustable for tension, while the left-hand one is equipped with a clearance-setting dial. For grinding tools with taper shanks a workhead can be fitted to the table slot. It is double ended, a different taper being provided at each end, and the spindle is mounted in anti-friction bearings. The tapers available are: at one end, No. 50 Series National Standard; at the other end, No. 12 B. & S. or No. 5 Morse, according to choice. Lubrication of the slide bearings, wheelhead vertical adjustment and cross-feed screw is by a built-in "one-shot" system, operated by a handle in the wheelhead slide.

The Cincinnati cutter and tool grinder has a capacity of 8 in. diameter and 15 in. between centres. A set of fittings is provided to enable a wide range of work to be ground.



This liquid level controller can be adjusted in accordance with the specific gravity of the liquid which is to be controlled.

LIQUID LEVEL CONTROLLER

Displacement Type Instrument for Air Operation

A new air-operated displacement-type liquid level controller in the Mason-Neilan series 12800 is now in production by the Crosby Valve and Engineering Company, Limited, Ealing-road Wembley, Middlesex. It supersedes the earlier series 12600 models.

The operating principle of the new controller remains the same; that is, a body displaced by the liquid rotates a torque tube to which is attached a slotted arc lever. This can be seen in the centre of the instrument shown in the illustration. This in turn operates a compressed-air valve through a series of levers which can be adjusted to suit requirements. When connected to the " direct " slot as shown, increase in liquid level increases the output air pressure. The opposite occurs when the " reverse " connection is applied.

In the new model, the instrument case is mounted directly on to a cast-iron frame which is itself bolted to the torque tube housing, thus eliminating the possibility of any control offset due to mishandling of the instrument case. The specific-gravity adjustment scale, which enables the instrument to be set for the density of the liquid being controlled, has been widened to a range of from 0·5 to 1·4 so serving most applications with one scale. The set point scale has been considerably increased in length; the method of adjustment is simplified and it is so arranged that a 3 to 15 lb. per square inch bellows for remotely setting the control point can easily be provided. A new and improved reset or integral-action resistance unit can readily be fitted to a standard proportional controller on site. The size of the torque tube mechanism chamber has been reduced, thus saving both weight and space, and the dimensions between connection centres now conform with international standards. The new pilot valve uses slack diaphragms of special materials in order that it may be sensitive and have long life. In addition, it incorporates a jewel orifice fitted with a plunger for cleaning while the instrument is in operation. The method of setting the accurately calibrated proportional band has been improved to facilitate setting and locking.

The controller is available for mounting with the displacer either inside or outside the vessel concerned, and can be supplied as a proportional controller with or without reset, as a transmitter, as a specific-gravity transmitter or controller or as a combined controller and transmitter. Models are available for level ranges of 14 and 32 in., 4, 5, 6, 7, 8, 10 and 15 ft.

APPARATUS FOR MEASURING DRAWING QUALITY OF SHEET METAL

An instrument for carrying out a non-destructive test on sheet metal, to determine its comparative drawing qualities and its susceptibility to stretcher-strains during drawing operations, has been developed by the Jones and Laughlin Steel Corporation. The originator of the " Flex-Tester ", as it is called, is Mr. C. B. Buker, a metallurgist on their staff. The instrument is manufactured by Steel City Testing Machines Incorporated, 8817 Lyndon-avenue, Detroit 21, Michigan, U.S.A., and is distributed in this country by C. Tennant, Sons and Company, Limited, 4 Copthall-avenue, London, E.C.2.

The Flex-Tester is seen in Fig. 1; it consists of a rigid steel base bent up to an angle of 60 deg. to the horizontal. A slot or bracket on the end of the upturned tongue portion serves as a clasp to engage and hold the corner of the sheet material to be tested. The two notches seen on each side and near the base of the upturned portion are placed there to ensure that the instrument is truly centred on the corner of the sheet. An aluminium handle supports a dial indicator the protruding stem of which rests against the tongue.

In operation, the upturned portion of the tester is placed on the material to be tested with the corner of the sheet inserted in the bracket. The corner of the sheet is then bent upwards through the standard angle of 60 deg. by applying pressure and forcing the instrument steadily backwards until the base comes in contact with the flat sheet surface. The dial indicator registers the resistance offered by the material to the bending operation in " F " units. In order to enable the drawing qualities of materials of different thicknesses to be compared, the dial readings are converted to a standard value, based on a thickness of 0·035 in. For thicknesses other than 0·035 in. the dial readings are converted to the standard by means of a converter furnished with the instrument and illustrated in Fig. 2. The actual dial reading is set against the arrow shown on the left of the instrument and the converted " F " value is read off opposite the figure obtained for the thickness of the sheet as measured by a micrometer.

The intention of the designers of the instrument is that each user should establish his own comparative values suited to his particular needs, but it is pointed out, as an approximate guide, that a material having an " F " value of up to 55 is suitable for extreme drawing. Values of up to 60 indicate suitability for deep drawing, of up to 65 for moderate drawing, of up to 75 for easy drawing and of over 75 for very shallow drawing and forming only.

To determine the susceptibility of the sheet material to stretching strains the Spherometer shown in Fig. 3 is employed. The Flex-Tester is removed carefully from the bent corner of the

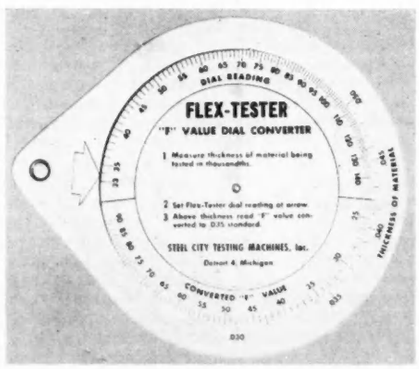


Fig. 2 Rotary converter for standardising dial readings of the Flex-Tester.

Fig. 1 The drawing qualities of sheet metals are measured by engaging a corner of the sheet in the bracket of the upturned tongue and pressing the instrument back through 60 deg.

sheet under test so as not to disturb the permanent set of the material. The Spherometer is then placed across the trough of the bend in the sheet and at right angles to it. The curvature is thereby measured and the reading obtained is in " R " values. It is pointed out that the lower the Spherometer reading, the less is the tendency of the material tested to stretcher strains and that no conversion is necessary for this reading on account of variations in thickness. The makers state that an " R " value of 30 or less is required for freedom from stretcher strains. Usually, however, material showing an " R " value of up to approximately 50 can be relieved of liability to stretcher strains by adequate roller levelling immediately prior to the drawing operation.

Although the apparatus is intended to forecast performance rather than to measure specific physical qualities of a material, it is stated that there is usually good correlation between the " F " values and those for the yield point and Rockwell hardness and cupping-test results.

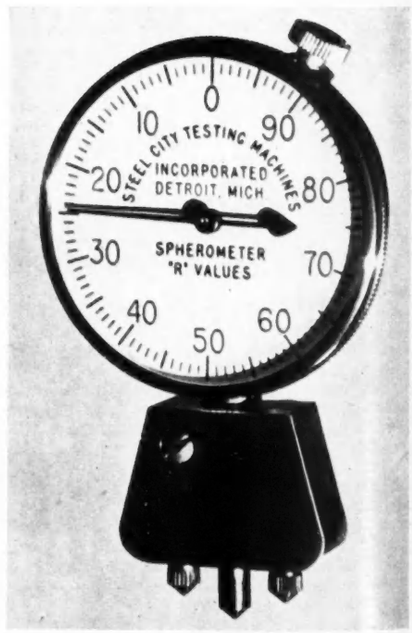
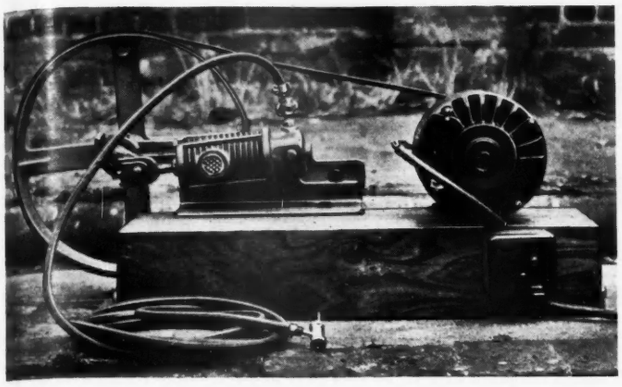


Fig. 3 Spherometer for measuring the curvature of the permanent set of the sheet and deducing liability of the material to stretcher strains.



The Komag air pump has been made into a self-contained compressor unit by mounting it with an electric motor on a bedplate, and using a large drive pulley to reduce the motor speed.

LIGHT PORTABLE COMPRESSOR

A small compressor unit which can be mounted on tractors or on a fabricated base as shown in the illustration is distributed in this country by Lawrence Edwards and Company, Oxford-street, Kidderminster. The unit is called the "Komag," and has a capacity of 150 lb. per square inch and an output of approximately 3 cub. ft. per minute at 500 r.p.m. Is designed for tyre inflation and airline equipment generally, and weighs about 14 lb. The Komag pump may be driven by transmission shafts of 1⅛-in. or 1¾-in. diameter, and is suitable for attachment to agricultural and industrial tractors and Land Rovers. In the illustration the pump has been mounted with an electric motor on a wooden bedplate, and the necessary speed reduction to 500 r.p.m. has been achieved by a 13½-in. diameter drive pulley.

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LAUNCHES AND TRIAL TRIPS

S.S. "JAMES ROWAN."—Single-screw self-trimming collier, built by Hall, Russell & Co. Ltd., Aberdeen, for the British Electricity Authority, London, S.W.1 (Managers: Stephenson Clarke Ltd., London, E.C.3). Main dimensions: 323 ft. between perpendiculars by 43 ft. 3 in. by 25 ft. 9 in.; deadweight capacity, about 3,700 tons on a draught of 18 ft. Direct-acting triple-expansion steam engine, of reheat design, developing 1,475 i.h.p. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland. Steam supplied by two oil-fired cylindrical boilers. Trial trip, May 15.

M.S. "FERNCOURT."—Single-screw oil tanker, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for Fearnley and Eger, Oslo, Norway. First of four vessels on order for these owners. Main dimensions: 570 ft. between perpendiculars by 77 ft. by 42 ft. 9 in.; deadweight capacity, 24,200 tons on a summer draught of 31 ft. 10 in.; oil-carrying capacity, 1,200,000 cub. ft. Eriksbergs-B. and W. eight-cylinder single-acting two-stroke Diesel engine, developing 10,000 b.h.p. Speed, 15¾ knots. Launch, June 16.

M.S. "SOUTHERN SATELLITE."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for Chr. Salvesen & Co., Leith. Third vessel constructed for these owners. Main dimensions: 525 ft. between perpendiculars by 71 ft. by 39 ft. 3 in.; deadweight capacity, 17,475 tons on a summer draught of 30 ft. 6¾ in.; oil-tank capacity, about 16,475 tons. N.E.M.-Doxford six-cylinder single-acting two-stroke opposed-piston oil engine, developing 6,800 b.h.p. at 119 r.p.m., constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Engine arranged to operate on heavy oil. Service speed, about 15 knots. Trial trip, June 20 and 21.

M.S. "MINIKOI."—Single-screw cargo vessel, with accommodation for a small number of passengers, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, to the order of the Swedish Eastasiatic Co., Gothenburg, for the joint use of that firm and the Swedish American Line, Gothenburg, both organisations forming part of the Bromstedt group of companies. Main dimensions: 445 ft. between perpendiculars by 62 ft. by 38 ft. 6 in. to shelter deck; deadweight capacity, 8,400 tons on a draught of 25 ft. 9¼ in.; cargo-carrying capacity, 538,700 cub. ft. (including 39,000 cub. ft. refrigerated space). Eriksbergs-B. & W. seven-cylinder single-acting two-stroke Diesel engine, developing 8,300 b.h.p. and arranged for operating on heavy oil. Service speed, 17 knots, fully loaded. Delivered, June 21.

M.S. "WHANGAROA."—Single-screw refrigerated-cargo vessel, with accommodation for eight passengers, built and engined by John Brown & Co. Ltd., Clydebank, for the New Zealand Shipping Co., Ltd., London, E.C.3. Main dimensions: 439 ft. 3 in. by 62 ft. 9 in. by 39 ft. 6 in.; gross tonnage, 8,750. Brown-Doxford six-cylinder opposed-piston oil engine, developing a service speed of 16¼ knots. Launch, June 21.

S.S. "BRUIN."—Single-screw vessel for the carriage of timber and general cargo, built and engined by Hall, Russell & Co., Ltd., Aberdeen, for A/S Jelolinjen (Managers: Fred Olsen & Co.), Oslo, Norway. Main dimensions; 265 ft. between perpendiculars by 44 ft. by 19 ft. 3 in. to main deck; deadweight capacity, about 2,500 tons on a draught of 16 ft. 10 in. Hall Russell-Fredriksstad double-compound four-cylinder steam engine. Steam supplied by two oil-fired cylindrical boilers. Trial trip, June 21.

S.S. "EMPRESS OF BRITAIN."—Twin-screw passenger and cargo vessel, built and engined by the Fairfield Shipbuilding and Engineering Co., Ltd., Glasgow, for the Canada to United Kingdom service of Canadian Pacific Steamships Ltd., Liverpool. Accommodation provided for 150 first-class and 900 tourist passengers. Vessel fitted with Denny-Brown stabilisers. Main dimensions: 640 ft. by 85 ft. by 48 ft.; gross tonnage, 26,000. Two sets of geared steam turbines developing 30,000 s.h.p. and a service speed of 21 knots. Steam supplied by two Foster Wheeler boilers. Launch, June 22.

S.S. "KINGSTON SAPPHIRE."—Single-screw trawler, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for the Kingston Steam Trawling Co., Ltd., Hull. Last of three vessels for these owners. Main dimensions: 189 ft. by 32 ft. by 17 ft. 6 in.; gross tonnage, about 800; fishroom capacity, 16,940 cub. ft. Triple-expansion steam engine constructed by Charles D. Holmes & Co., Ltd., Hull. Steam supplied by one oil-fired multitubular boiler. Launch, June 22.

S.S. "BERTHA."—Twin-screw tug, built and engined by Ferguson Brothers (Port-Glasgow) Ltd., Port-Glasgow, to the order of the Crown Agents for Oversea Governments and Administrations, London, S.W.1, for service at Lagos, Nigeria. Main dimensions: 110 ft. by 31 ft. by 12 ft.; gross tonnage, 330. Triple-expansion steam propelling engines and one oil-fired boiler. Launch, June 23.

M.S. "DEFENDER."—Single-screw cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for the Charente Steam Ship Co., Ltd. (Managers: Thos. and Jas. Harrison Ltd.), Liverpool. Main dimensions: 464 ft. overall by 59 ft. 6 in. by 37 ft. 8 in.; deadweight capacity, about 9,600 tons. Doxford four-cylinder opposed-piston oil engine. Service speed, about 13½ knots. Launch, June 23.

S.S. "CHARLES H. MERZ."—Single-screw self-trimming collier, built by Hall, Russell & Co., Ltd., Aberdeen, for the British Electricity Authority, London, S.W.1 (Managers: Stephenson Clarke, Ltd., London, E.C.3). Main dimensions: 323 ft. between perpendiculars by 43 ft. 3 in. by 25 ft. 9 in.; deadweight capacity, about 3,700 tons on a draught of 18 ft. Direct-acting triple-expansion steam engine of reheat design, developing 1,475 i.h.p. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland. Steam generated by two oil-fired cylindrical boilers. Launch, June 23.

M.S. "TYRIA."—Single-screw cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for the Anchor Line Ltd., Glasgow. Main dimensions: 425 ft. by 57 ft. 9 in. by 29 ft. 1 in.; deadweight capacity, about 9,300 tons. Doxford four-cylinder opposed-piston oil engine. Trial trip, June 28.

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LLOYD'S REGISTER BOOK IN NEW FORM

Compression Without Reduction of Information

Lloyd's Register of Shipping will shortly be sending their 1955-56 Register Book to subscribers, and for the first time since 1890 there has been a major revision in the layout and content of the Register. The Register of Ships is now contained in a single volume no greater in weight or bulk than one of the two volumes which have hitherto been required. This has been achieved partly by transferring some information of a technical character to the Appendix, but mainly by using a thinner paper specially developed for the purpose to ensure toughness and opacity.

The Supplements to the Register Book will in future play a more important and useful role. They will be produced in cumulative form, and each Supplement will contain complete records of all the most recent periodical surveys held on every ship classed with the Society. In addition, it will contain the latest information regarding alterations (such as change of name, ownership, flag, tonnage, etc.) to the particulars given in the Register of Ships for all ships, whether classed with the Society or not. Lastly, it will form an index to the New Entries to the Register of Ships which will be published simultaneously with each issue of the Supplement. Due to the extra work involved in producing the Supplement in cumulative form it will only appear monthly instead of fortnightly as hitherto.

New entries to the Register of Ships, which include ships which have changed their name as well as new ships, amount to close on 4,000 in the course of a year and on this account it has not yet proved feasible to produce them in cumulative form. However, each monthly issue of New Entries will be conspicuously numbered on every page and this number will appear as a guide in the Supplement. No difficulty should therefore be experienced in locating a new entry if the Supplement is used as an index. A convenient form of binder capable of many years service is available to hold the current issue of the Supplement and the accumulation of new entries.

With the compression of the Register of Ships into a single volume the Appendix becomes Volume II of the Register Book. It too has been re-arranged to a considerable extent and the first three sections contain a variety of technical particulars for ships other than tankers; for tankers; and for refrigerated-cargo installations. Other well-known features such as the lists of ships whose names have been changed and of those which have compound names; ships recorded under nationality and tonnage divisions; shipbuilders and existing ships which they have built; dry and wet docks; telegraphic addresses, etc., have been retained, but again owing to the use of thinner paper, Volume II will be reduced in bulk to about three-quarters that of the new Register of Ships.

The set is completed by a third, smaller, volume containing the names of all owners recorded in the Register of Ships with lists of their fleets. This has deliberately been kept as a separate publication—although from the point of view of bulk it could have been included in the Appendix—in order that it may be more conveniently available for reference.

Labour Notes

DOCK STRIKE ENDED

The strike of members of the National Amalgamated Stevedores and Dockers came to an end last Monday, when the men returned to work in large numbers. Following a decision by the London members of the union's executive committee, to ask for an immediate resumption of work, resolutions of a similar nature were passed by large majorities at mass meetings of strikers at Hull, Birkenhead, Liverpool and Manchester, on Sunday.

Although deciding to return to work, the men at the Northern ports made it clear that they were doing so in the capacity of members of the N.A.S.D. and that they would continue to fight for the recognition of that union as a fully-negotiating body at their ports, just as it always has been in the Port of London.

As is well known, it was in support of this claim that the union had begun the strike action six weeks previously. Since an earlier dock strike, about 18 months ago, the union had steadily recruited members at the Northern ports and, when strike action began, claimed to represent substantial numbers of dockers in these centres.

The only recognised union at the Northern ports is the Transport and General Workers' Union and this organisation's executive committee firmly declined to concede negotiating rights to the N.A.S.D., alleging that that union had obtained its members in the North by "poaching" among members of their own union, the T.G.W.U.

CONFUSION AMONG STEVEDORES

The men concerned were estimated to number about 10,000 and the T.G.W.U. claimed their return. The N.A.S.D. was equally unsuccessful in its approach to the port employers, against whom the strike was ostensibly directed. The employers' organisations took the view that representation on local negotiating committees was a matter for settlement between the unions concerned and they declined to change that decision.

From the beginning of the strike, the members of the T.G.W.U. remaining in that body (the great majority) gave full support to their union and continued at work. The difficulty was referred to the disputes committee of the Trades Union Congress, which announced on June 29 that the members of the N.A.S.D. at the Northern ports had not been properly recruited and that the union must relinquish them forthwith.

The executive committee of the N.A.S.D. accepted the T.U.C. decision and, presumably, will take steps to remove the men affected from its books. There was no ruling by the T.U.C. as to what men so treated should do about their trade-union membership. As one of the stevedores' organisers declared, it appears that they can either apply to re-join the T.G.W.U., remain outside any union, or continue to claim membership of the N.A.S.D. and fight on for its recognition.

All through the strike, there have been cross currents and divided counsels, and the difficulties of the N.A.S.D. were increased by the resignations of its general secretary, stevedores' section secretary, and dockers' section secretary during the strike. The resulting confusion among the N.A.S.D. and its members seems likely to continue.

AUTOMATION NOT A DANGER

Suggestions that the introduction of automatic methods of production need have no terrors for active trade unionists are contained in an editorial article by Mr. R. Edwards in the current issue of the *Chemical Worker*, the official journal of the Chemical Workers' Union.

Mr. Edwards, in addition to being the general secretary of the union, is Labour Member of Parliament for Bilston, Staffordshire. He states that workpeople who belong to well-organised unions, that are articulate and full of awareness of the present scientific age, should not worry about the consequences of automation.

Far too many unions and far too many workers, he considers, linger on in an old rut, hoping to solve the problems of these times by antiquated methods based on the Luddite rebellion in the early years of last century, when bands of mechanics organised riots for the destruction of machinery.

Outdated economic textbooks are no guide to the future because a new technical, atomic and chemical revolution is being unfolded. It is to this revolution that workers should turn their eyes, in the certain belief that, given 20 years of peace, the world and this country will move into an era of superabundance.

STRIKE-FREE RECORD

Much of the credit for the long period during which the building industry had remained free from any form of major strike action, must be accorded to the good relations existing between managements and workpeople.

This view was expressed by Mr. Harvey G. Frost, the President of the National Federation of Building Trades Employers, at the half-yearly general meeting of the Yorkshire Federation of Building Trades Employers, at Scarborough, on Friday last. He said that the industry's consultative machinery was so designed as to provide for a period of reflection in cases where it was needed and the result had been that the building industry had suffered no major stoppage of work for about 30 years.

It was, indeed, significant that the industry's joint consultative machinery had worked with equal smoothness during periods of industrial extremes. This state of affairs applied both to the years of widespread unemployment before 1939 as well as to the post-war era of full employment.

The building industry's experience in the field of human relations had served to stress the wisdom of Sir Walter Monckton's recent statement, in which the Minister had emphasised the importance which should be attached to providing a period for reflection and consideration, before managements and workers became involved in an atmosphere of strikes and strike notices.

WAGES AND STRIKES

Some 961,000 workpeople in the United Kingdom received increases in their full-time weekly wages during May, and these were estimated to amount to a total of about £365,000 net, representing an all-round average of over 7*s.* 6*d.* a head.

The *Ministry of Labour Gazette* for June records that, among the principal groups of workpeople who benefited from these increases were manual employees in the service of local authorities in England, Wales and Scotland, persons engaged in industrial and staff canteens, merchant seamen, and non-skilled workers paid at miscellaneous rates in many Government industrial establishments.

In industries in Northern Ireland engaged in building and civil-engineering contracting work, there were increases of 2½*d.* an hour for craftsmen and of 1½*d.* an hour for labourers. In the vehicle-building industry, throughout the United Kingdom, there were increases of 2*d.*, 2½*d.* or 3*d.* an hour, according to occupation, for men, and of 2*d.* an hour for women.

During the five months ended May 31 last, some 9,890,500 persons received net increases amounting to a total of £3,870,500 in their weekly wages.

Stoppages of work in the United Kingdom, owing to industrial causes, were substantially more serious in May last than in May, 1954. There were 266 strikes in progress in May last and, in them, no fewer than 201,500 persons were involved, and a total of 838,000 working days lost. The comparative figures for May, 1954, were 200 strikes with only 29,200 persons involved and 111,000 days lost. The most serious stoppages in May last occurred in the coal-mining industry, where 209 strikes took place, involving 121,900 miners and causing the loss of 581,000 days.

PRODUCTIVITY INCREASED

Official figures issued during recent months indicate not only that industrial productivity in Britain is increasing, but that the pace, compared with that attained in previous years, is improving. Production by all industries for May last is tentatively estimated to have reached a level of between 137 and 138, according to the index of production prepared by the Central Statistical Office of the Treasury.

This level compares with revised figures of 132 for April and of 141 for March. The corresponding figures for these months last year were 124 and 130, respectively, and a figure of 133 was recorded for May, 1954.

A comparison of the all-industries figure for April last with that for April, 1954, shows an advance of over 6 per cent. Similarly, the level reached in May last is nearly 4 per cent. above that for May, 1954, and this difference is increased when allowance is made for holidays. This year, the Whitsuntide holidays came into the May period, whereas last year they took place in June.

Treasury figures require to be corrected for seasonal variations of this nature in order that the progress of industrial production during recent months may be fully realised. The index figures of the Central Statistical Office are based on the average production during 1948, which is taken as 100.

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NOTICES OF MEETINGS

Birmingham Exchange and Engineering Centre

BIRMINGHAM

"Automation," by Frank G. Woollard, at the Birmingham Exchange and Engineering Centre. Tickets, for which there is no charge, may be obtained on application to Mr. S. Owen, secretary of the Birmingham Exchange and Engineering Centre. Thurs., July 14, 6.30 p.m.

East Anglian Regional Advisory Council

CAMBRIDGE

"Fuel Efficiency Pays." One Day Conference, held in conjunction with the National Industrial Fuel Efficiency Service. 10.30 a.m., "Fuel-Saving Equipment and the Government Loan Scheme," by Rear-Admiral Sir Sydney O. Frew; and "Reducing Steam-Raising Costs," by S. N. Duguid. 2.15 p.m., "Boiler-House Instruments and Their Value," by W. R. L. Kent; and "Steam Saving Pays," by L. G. Northcroft. Shire Hall, Cambridge. Thurs., July 14. Apply as below.

NORWICH

"Fuel Efficiency Pays." One Day Conference, held in conjunction with the National Industrial Fuel Efficiency Service. Papers and authors as above. Norwich City College and Art School, Ipswich-road, Norwich. Wed., July 13, 10.30 a.m. and 2.15 p.m. Apply as below.

Society of Chemical Industry

BIRMINGHAM

Annual Meeting, held under the auspices of the Birmingham and Midland Section. Various papers, visits and excursions. Grand Hotel, Birmingham. Mon., July 11, to Sat., July 16. Reception by Sir Hugh and Lady Chance, at the University Union, Mon., July 11, 8 p.m.

Annual Business Meeting at Birmingham University, 10 a.m.; and Civic Reception at Council House, 8 p.m. Tues., July 12. "The Use of Radioactive Isotopes for Continuous Control in Industry," by Dr. G. B. Cook, 9.30 a.m.; "Gasification for Town Gas Manufacture," by Dr. F. J. Dent, 9.30 a.m.; and "Colloid Science," by Sir Eric Rideal, 11 a.m.; all at the Birmingham University. Annual Dinner at the Grand Hotel, 7.30 p.m. Wed., July 13.

"New Developments in Electrodeposition," by H. Silman, 9.30 a.m.; "Quality Control in the Food Industry," by C. A. Bassett, 9.30 a.m.; and the Chance Memorial Lecture on "Welfare in Industry," by H. V. Potter, 11 a.m.; all at the Birmingham University. Reception by the University in the Barber Institute of Fine Arts, 8 p.m. Thurs., July 14.

"Aspects of the Use of Copper-Nickel Alloys in the Chemical and Allied Industries," by M. A. Comley and E. Warde, 9.30 a.m.; "Chemistry and Ceramics," by Dr. A. T. Green, 9.30 a.m.; "Some Aspects of the Corrosion of Cast Iron," by R. I. Higgins, 11 a.m.; and "Polyester Resins: Their Chemical Nature and Industrial Uses," by L. H. Vaughan, 11 a.m.; all at the Birmingham University. Reception by the Dunlop Rubber Co., Ltd., Birmingham University, 8.30 p.m. Fri., July 15.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham 2. (Midland 1914.)

East Anglian Regional Advisory Council for Further Education. Apply to Dr. F. Lincoln Ralphs, conference secretary, County Education Office, Stracey-road, Norwich. (Norwich 22288, Extension 151.)

Society of Chemical Industry, 56 Victoria-street, London, S.W.1. (VICtoria 5215.)